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SOME RECENT CHEMICO-PHYSIOLOGICAL DISCOVERIES REGARDING THE CELL.[1]

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In opening this discussion, or rather in making such remarks as seem appropriate in connection with the subject before us for consideration this morning, I am reminded that the chemistry and the chemical processes of the cell have received very little attention from the generality of biologists. This is perhaps natural, since the morphological side of biology has for many years presented a more attractive field for the majority of scientific workers, and the difficulties have not been so great as in the chemical and physiological problems awaiting solution.

Simplicity of structure, as embodied in the single cell of a unicellular organism, means to the physiologist increased complexity of function. In the higher organism with its many groups of cells, we can easily comprehend how one group may be characterized by one line of functional activity, while a neighboring group of cells in the form of another tissue or organ is endowed with functional activity of quite a different order. One group of cells is set apart for one line of duties, while another group has quite different functions; in other

[1] The Introductory paper in a discussion of our present knowledge of the cell at the meeting of the American Society of Naturalists, New Haven, Dec. 28, 1893.

words, structural differentiation has begotten or accompanied chemical and functional differentiation. All this seems quite plausible, indeed, quite natural, but how shall we explain all the varied functions possessed by the unicellular organism unless we accept the idea of a possible chemical differentiation of the cell protoplasm inside the cell wall. Digestion, assimilation, excretion and reproduction are functions possessed alike by the unicellular organism and its higher neighbor the multicellular organism. In the latter, we recognize distinct groups of specially characterized cells for each phase and form of functional activity, each group as in a gland or tissue having a different chemical structure with its own peculiar line of chemical activity and its own particular katabolic products. In the unicellular organism, on the other hand, a differentiation of protoplasmic particles is the only plausible explanation of the diverse functions of the living cell.

This being true we can no longer look on the cell as the ultimate unit of structure, certainly not from the chemical standpoint. The cell may be considered rather as a complex molecule, or series of molecules, built up of many morphological atoms or rather groups of atoms. Thus, the cytoplasm, for example, may be looked upon as a multitude or mass of living units of structure, as the plasomen of Wiesner. Call them what you will—plasomen, idiosomes, gemmules, plastidules, idioblasts or physiological units—these particles have the power of dividing, and, indeed, of growth and assimilation. Moreover, it is possible that this power of growth and reproduction may be independent, in part at least, of the cell nucleus and the constituent karyoplasm. Furthermore, the nucleus too may perhaps be considered as composed of auto-divisible organic individuals, these hypothetical particles, both of the cytoplasm and of the karyoplasm, being considered as the living atoms of the molecule, the last divisible living bodies of the cell.

For fifty years or more, the cell theory of structure and development as outlined by Schleiden and Schwann has been the nucleus for nearly all phases of biological work, and although our knowledge of the cell has advanced greatly in

all directions during the last half-century, yet nearly all the problems of life are still viewed from the standpoint of the cell theory; morphological facts and physiological facts are all tested more or less by their relationship to cell structure and cell function. As Whitman[2] has aptly said "all the searchlights of the biological sciences have been turned upon the cell; it has been hunted up and down through every grade of organization; it has been searched inside and out, experimented upon, and studied in its manifold relations as a unit of form and function", and yet, if I understand the matter aright, many morphologists to-day are inclined to protest somewhat against "the complete ascendency of the cell as a unit of organization." We must not ignore the existence of the organic chemical compounds, with their peculiar molecular structure, which compose the cell protoplasm; the whole secret of organization, assimilation, growth, development, etc., may rest upon these ultimate elements of living matter. These may be the actual representatives of the physiological units of Herbert Spencer, or the plasomes of Wiesner; they may be the real units of all forms of living matter, the bearers of heredity and the true builders of the organism whether it be simple or complex. These protoplasmic particles are not necessarily limited in their action, or in the influence they exert, by cell walls or other boundaries.

The physiologist, however, like all other biologists, has been wont to look upon the cell as "the unit of the manifold variable forms of the organism" (Hammarsten), representing the seat of the many varied chemical processes characteristic of the individual tissues and organs. The cells naturally, through their variable activity, govern the range and intensity of the metabolic processes of the organism; but all this is simply a general expression of the idea that the chemical processes of the higher organism are localized in the cellular tissues of the body rather than in the adjacent fluids. It appears to me that we have every reason to believe in the existence of ultimate particles of living matter, both cytoplasm and karyoplasm, in-

[2]The inadequacy of the cell-theory of development. Journal of Morphology, Vol. 8, p. 639.

side the cell, which are the real units of the organism. They may not be recognizable morphologically, but they exist nevertheless as individual links in that chain of molecules of which we believe living protoplasm to be composed. As Quincke[3] has recently said " bioiogical science must, well or ill, take into account the fact that the development of the cell and the life of organic nature depends on masses and layers which cannot be seen by the microscope alone." Hence, the chemistry of the cell offers an interesting field of work full of promise, although for the most part it has been studied mainly with a view to obtaining more light regarding the general metabolic processes of the higher organisms.

From a chemical standpoint, the living animal cell may be considered as a combination of varied chemical substances always in a state of unequilibrium, unstable in the highest degree, readily prone to break down by oxidation or cleavage into bodies of less complexity, each downward step in the process of disintegration, giving rise to the liberation of a certain amount of energy. These explosive, or it may be gradual, decompositions are going on continually as long as life endures, and chemical transformations and chemical decompositions are therefore an essential part of the life history of the cell, or of the organism of which it is an integral part. In them are hidden many of life's mysteries, and some of the most intricate as well as important phases of physiological phenomena are closely connected with these more or less obscure chemical transformations.

This constant liberation of energy, so characteristic of the living animal cell, coming as it does from the continued disintegration of the living substance of the organism creates a demand for fresh material to supply the place of that which has undergone this vital decay, otherwise the vital energies flag and the bodily structure withers away. The food material supplied to meet this demand, although it may be easily oxidizable or combustible cannot supply the needs of the organism without becoming vitalized. As dead, inert matter it is simply combustible; it can exhibit energy as heat only like

[3]Nature. Vol. 49. p. 6.

other forms of organic matter, but its energy cannot be made available in the manner required by the living animal organism. It must first be fitted for assimilation through digestion or otherwise; after which, having passed into the circulating fluids, it finally reaches the cell under whose influence it undergoes a final change by which it is raised to a higher plane. That which was dead has become alive, a chemical transformation has occurred, the atoms in the molecule have been rearranged and we have to deal with living matter; a change accomplished through the anabolic power of the living cell, or better of the cell protoplasm. Anabolism and katabolism, construction and destruction, are thus going on continually in the living animal cell side by side as a necessary concomitant of life, but the processes are not everywhere of the same order. They are qualitatively and quantitatively unlike, especially the katabolic, the latter showing some peculiarities characteristic of almost every individual group of cells as comprised in individual organs or tissues. Each individual cell as a component of the many and varied tissues of the organism is to be compared to a well equipped chemical laboratory, the character and amount of the work produced being dependent in part upon the intrinsic qualities of the cell, *i. e.* of the cell protoplasm, and in part upon the nature of its surroundings or environment. While these statements apply more particularly to the animal cell, they are likewise true of the vegetable cell, the only difference being that in the latter we find a predominance of synthetical processes, a remarkable power of building up complex substances such as starch and proteid out of the simple food material obtained from the air and the soil, while the animal cell is especially characterized by the extent of its katabolic processes.

It is thus very evident that while in the early stages of growth and development, all animal cells, for example, may show a striking similarity in composition, as soon as differentiation in form begins to manifest itself with an accompaniment of functional activity, chemical composition is gradually altered until at last each group of cells characteristic of the individual organs and tissues acquires a composition peculiar

to itself. Obviously, however, the most striking differences are manifested in the character of the so-called secondary constituents of the cell protoplasm, *i. e.* the katabolic products of the cell's activity, such as the different enzymes or their antecedents, the albuminoids, pigments, fat, glycogen, etc., to which must be added the substratum of dead food material for the nutrition of the cell. From this very diversity in the character of the katabolic products of protoplasmic activity, we might easily argue corresponding differences in the character of the primary constituents of the cell protoplasm, which in turn would imply fundamental differences in the nature of the anabolic processes by which the cell protoplasm is formed.

It will be seen from what has just been said that it is not an easy matter to discriminate between the primary constituents of a cell and the so-called secondary constituents, or such as arise from the katabolic activity of the primary bodies. Furthermore, it is an extremely difficult matter to isolate from a given tissue or organ the active cells entering into its structure, or to collect together a sufficient number of unicellular organisms free from impurities or admixtures. When, however, this has been accomplished and we are ready to analyze the isolated cells, we are at once confronted with the limitations attending this kind of work, especially the fact that any ordinary method of separation or analysis, even the initiatory steps in the process, immediately transforms the living matter into dead matter, which transformation may be accompanied by cleavage or other chemical changes of more or less complexity; so that the bodies we identify as components of the cell protoplasm may be simply alteration products, or fragments of the larger and more complex molecules resident in the living matter.

From microscopical examination we have evidence that protoplasm is far from being homogeneous, that it is loaded with granules and pervaded by a mesh-work of irregular arrangement. These various forms of protoplasmic differentiation have, as you know, been variously named by different investigators, as the spongioplasm, paraplasm, hyaloplasm, etc.,

and we are led to infer marked differences in chemical composition from the behavior of the several parts of the cell toward the many pigments or dyes used in histological investigation. There can be no manner of doubt that the differences in color between the nucleus and the cytoplasm of the cell, for example, as brought out by the agency of various pigments is due to differences in chemical composition. Again, as you are well aware, Ehrlich has been able to discriminate between the different varieties of granules found in cell protoplasm by their behavior toward neutral, acid and alkaline aniline dyes. Thus, in the centresome we have a mass of differentiated cytoplasm, which as Watasé[1] has shown in the egg of Unio, may be made to stand out with great distinctness by means of acid-fuchsin, while the spindle fibres and the rays of the aster remain practically unstained, thus clearly pointing to differences in chemical composition which are well worthy of note. Again, there are still other granules frequently present in the cytoplasm of many cells, staining dark with osmic acid, which indicate still other differences in chemical composition. But our knowledge concerning the chemical nature of protoplasm is far too imperfect and scanty to admit of our drawing any other than the broadest generalizations from the affinity the protoplasm may show for various pigments.

Further, as you well know, the nuclear constituents have been divided by various investigators, as by Flemming, into several groups according to the action of different stains; thus, we have the chromatic substance or chromatin, which stains readily with the aniline dyes and which comprises especially the nuclear network, then achromatin, or that portion of the nucleus which does not stain readily, as the nuclear matrix and the nuclear membrane.

Such statements as these may be added to almost indefinitely, but for our purpose the above are amply sufficient to indicate the existence of marked chemical differences in the cell cytoplasm and karyoplasm. And, indeed, that is all they do indicate; they give us very little knowledge of the real nature of the substances which are the cause of these differ-

[1]Homology of the Centresome. Journal of Morphology, Vol. 8, p. 433.

ences in reaction. We must have more definite chemical knowledge before we can hope to attain to a clearer understanding of the actual make up of cell protoplasm. Further, such knowledge is not to be obtained solely by micro-chemical study. The latter is surely important, but macroscopical methods must be relied upon mainly to furnish the desired information, and when we have full knowledge of the chemical nature of the substances present in the protoplasm, we may hope to find micro-chemical methods adapted to their accurate detection.

What now is the state of our knowledge regarding the primary constituents of cell protoplasm? Taking the results which have been elaborated by painstaking work during the last ten years, I think we are justified in asserting that the primary constituents of the cytoplasm are especially a peculiar group of proteid or albuminous bodies known as nucleo-albumins and characterized by containing phosphorus. These are by far the most numerous of the substances present in the cytoplasm. Next in importance are simple proteids belonging mainly to the group of globulins, a class of albuminous bodies insoluble in water but readily dissolved by 5–10 per cent. salt solution. Lecithin comes next, a complex phosphorized body having a constitution similar to that of a fat and yielding by decomposition higher fatty acids, glycero-phosphoric acid and cholin. This body is also insoluble in water and likewise in salt solution, but is readily dissolved by ether and somewhat by alcohol. Another substance almost invariably present in cytoplasm is cholesterin, a solid crystalline alcohol of somewhat uncertain constitution, insoluble in water and salt solution, but readily soluble in alcohol and ether. The remaining constituents of the cytoplasm are the inorganic elements calcium, magnesium, potassium and sodium united with chlorine and phosphoric acid to form chlorides and phosphates respectively. It may be somewhat questionable whether all of these latter salts are primary constituents of the cytoplasm, although it seems quite certain that potassium which is present in fairly large quantities in animal cells is a true primary constituent. Potassium phosphate is certainly

of primary importance for the life and development of the animal cell, as no doubt also are the earthy phosphates, although we can hardly formulate how they exist in the cytoplasm unless it be in close union with the proteids or nucleo-albumins of the cell, for which we know they have a strong affinity. Again, it is to be remembered that the ash of all cells shows the presence of a certain amount of ferric oxide. This, however, does not come from ordinary iron salts present in the protoplasm, but the iron appears to exist in some peculiar organic combination, apparently united to carbon. It is especially to be noted as a component of so-called iron-containing nucleins, or nucleo-albumins.

It is thus seen that proteid matter in some one or more forms, mostly as nucleo-albumins, constitutes the great bulk of cytoplasm, and the typical anabolic product of the living cell is unquestionably represented by a molecule, or molecules, in which proteid matter occupies a prominent place. "But that the albumin molecule is alone the bearer of life and all the other constituents of the protoplasm its satellites we certainly cannot affirm." (Kossel)

Between the cytoplasm and the karyoplasm there is very little constant difference. The one typical constituent of the cell nucleus, however, is nuclein or one of the bodies of that group. It is important to note in this connection that such examinations as have been made show that the primary constituents of the cell may be located in the nucleus in great part, or they may be evenly distributed through both cytoplasm and karyoplasm, or indeed they may be almost wholly wanting in the nucleus, occurring only in the cytoplasm.[5] This latter condition offers a ready explanation of the well-known fact that cells rich in nuclei and consequently containing only a little cytoplasm, as the spermatozoa, are extremely poor in many of the primary bodies of ordinary cells. The one body, however, characteristic of the cell nucleus is nuclein.

Cholesterin and lecithin are certainly common to both cytoplasm and karyoplasm, being found abundantly in cells rich

[5]Kossel. Verhandlungen d. physiol. Gesellschaft zu Berlin, Feb'y, 1890.

in nuclei as well as in cells poor in nuclear elements. We must reiterate, however, that the first place in importance among these so-called primary bodies is to be ascribed to the proteids in all living cells, for it seems more than probable that the nucleins and the lecithins found in cell protoplasm are constructed synthetically out of certain cleavage products of the proteids and phosphates. However this may be, the globulins, nucleo-albumins and nucleins are, so far as our present knowledge extends, the important constituents of cell protoplasm in all animal and vegetable cells. Of these three classes of bodies, the nucleins and the related nucleo-albumins are deserving of special notice.

The substance originally known as nuclein and first identified by Hoppe-Seyler and Miescher as the main constituent of the nucleus of pus cells was prepared by a number of investigators from different kinds of material rich in nuclei, or nuclear substance. Thus, Miescher prepared it from the spermatozoa of different animals, Geoghegan from the brain, Hoppe-Seyler from yeast cells, Plósz from the liver and von Jaksch from the human brain. The products obtained, however, while showing certain points in common, were unlike each other in many respects. Thus, they were all alike in containing a noticeable amount of phosphorus, but the percentage of phosphorus was found on analysis to vary from 1.8 per cent. up to 9.5 per cent. Again, the several products differed in their degree of solubility in alkalies, some being very soluble and others only slightly so. These marked discrepancies were naturally considered as implying that the so-called nuclein was not a chemical unit, but rather an indefinite mixture of organic phosphorus compounds with proteid matter; but we now know, thanks to the painstaking work of Kossel and others, that there are a group of closely related bodies, *nucleins*, widely distributed in nature, wherever cell structure is to be found, as the main constituent of the cell nucleus, and likewise present in certain substances such as milk and egg-yolk which serve as food for developing animals. The latter class are better known as nucleo-albumins, from which a typical nuclein can be separated or rather prepared by the

proteolytic action of the gastric juice,[6] which dissolves away the excess of proteid matter leaving a non-digestible nuclein. The essential points of difference between the typical nucleins are made clear by a study of their cleavage products. Thus, the nuclein found in the karyoplasm of most cell nuclei on being boiled with dilute sulphuric acid, yields as cleavage products, phosphoric acid, xanthin bodies and acid-albumin. The nuclein, on the other hand, present in the sperm of the salmon fails to yield any albuminous matter, its cleavage products being only phosphoric acid and hypoxanthin. The third group of nucleins, better known as nucleo-albumins, yield only phosphoric acid and albuminous bodies by cleavage, the xanthin bases, if formed, being in too small quantity to admit of certain detection. From the nuclein of yeast cells, Liebermann obtained by cleavage metaphosphoric acid, and both he[7] and Pohl were able to prepare a combination of metaphosphoric acid with egg-albumin, also with serum-albumin and with albumose, resembling nuclein in properties. Furthermore, by varying the proportions of acid and albumin it is possible to prepare different forms of nuclein, varying in their content of phosphorus, and in their solubility in alkalies, like the natural nucleins obtainable from cell nuclei. It is questionable, however, whether these synthetical products are in every way akin to the natural nucleins, for it seems probable that the nuclein molecule formed through the activity of the living cells is constructed on a somewhat different plan, so far as the arrangement of the atoms is concerned. Thus, Altman[8] has shown that when a nuclein is subjected to a mild process of decomposition, as on exposure to the action of an alkali at ordinary temperature, it is broken apart into albumin and a peculiar acid rich in phosphorus, to which the name of nucleic acid has been given. Moreover, it is possible to regenerate the nuclein out of these two components, the body so reconstructed having all the properties of the original substance. Nucleins, therefore, to quote Halliburton, may be considered

[6] Compare Lilienfeld Du Bois Reymond's Archiv f. Physiol. 1892, p. 129.

[7] Liebermann. Pflüger's Archiv für physiologie Bd. 43 p. 99.

[8] Ueber Nucleinsäuren. Du Bois Reymond's Archiv für Physiol, 1889, p. 524.

as compounds of proteid substances with nucleic acid, the various members of the group differing in the proportion of proteid matter to this phosphorus-rich acid. Thus, we may have a chain of nucleins, one end of the series being represented by nucleic acid itself with its 9 to 11 per cent. of phosphorus and without any admixed proteid, such for example as is found in the heads of the spermotozoa, which are doubtless derived from the nuclei of the spermatogenic cells; while in the middle of the series are the nucleins proper consisting of proteid with varying amounts of nucleic acid, and at the other extreme nucleins composed almost entirely of proteid, containing at the most only 0.5 to 1.0 per cent. of phosphorus and represented by the substances generally known as nucleo-albumins.

Nucleins are not digestible in artificial gastric juice, while a nucleo-albumin, as already stated, undergoes a partial digestion, the excess of combined proteid matter being converted into soluble products, while a typical nuclein remains as an insoluble residue, which however may be dissolved by weak alkalies. With this understanding of the general character of of the nucleins, many of the micro-chemical observations recorded by different workers in cytology become intelligible. Take as an illustration the work of Zacharias[9] on vegetable cells. This observer, as you remember, made a large number of digestive experiments with artificial gastric juice, and noted the occurrence in the nucleus of two distinct substances indigestible in pepsin-acid solution, which differed from each other in their solubility in acids and alkalies. As a result, Zacharias states that the resting cell nucleus consists of a ground mass composed in great part of nuclein, while the nucleoli consist of albumin and plastin. Remove the albumin from the nucleus by digestion, and the nuclein will dissolve in dilute alkali, leaving a network of plastin. Further, Zacharias states that plastin is an essential constituent of the total protoplasmic content of the cell, including the nucleus and the chromatophore. Now, note the differences between the nuclein and the plastin as defined by Zacharias. Plastin,

[9]Botanische Zeitung. 45th Jahrgang, pp. 281 and 329.

for example, does not dissolve or even swell up in 10 per cent. salt solution, hence it is not a globulin or simple proteid; further, it does not disappear on treatment with hydrochloric acid of moderate strength, as nuclein does. Again, plastin is much more difficultly soluble in alkalies than nuclein. Now as a matter of fact these two bodies have an extremely close relationship; they are both nucleins, having the same general type of structure; they differ merely in the proportion of nucleic acid and proteid. The plastin of the histologist, therefore, is simply a form of nuclein, less acid in character because it contains less nucleic acid and a larger proportion of proteid; hence, it likewise contains less phosphorus and for the same reason is more insoluble in alkalies.

In a general way we may say that the so-called nuclear sap or nuclear matrix is composed practically of a globulin-like body, just such as is found in the cytoplasm and which by digestion with artificial gastric juice is converted into soluble products, as proteose and peptone. The bulk of the nucleus, however, is composed of material insoluble in gastric juice. The bodies composing this indigestible matter are all phosphorized; in fact, they are nucleins of various kinds. Thus, the so-called chromatin network which is distinguishable from all other constituents of the cell by its strong affinity for various dyes is composed of a nuclein rich in phosphorus, viz.: a nuclein with a large content of nucleic acid and a corresponding smaller content of proteid. The nucleoli, on the other hand, which have a less pronounced affinity for dyes than the chromatin, are composed mainly of the so-called plastin, *i. e.* a nuclein comparatively poor in phosphorus and not readily soluble in alkalies. In other words, and this I think is the point deserving of special emphasis, the cell nucleus in all cells is composed mainly of nucleins, compound bodies made up of proteid matter and nucleic acid, the latter rich in phosphorus, the individual parts of the nucleus varying somewhat in accord with the varying character of the nucleins as determined by the proportions of proteid to nucleic acid. That is to say, "in the processes of vital activtiy there are changing relations between the phosphorized con-

stituents of the nucleus, just as in all metabolic processes there is continual interchange, some constituents being elaborated, others breaking down into simpler products."[10] We are not to forget, however, that these bodies may possibly be fragments of still more complex molecules resident in the living karyoplasm of cell nuclei. In any event, the character of these fragments, if such they are, must tell us something as to the nature of the original molecules, and consequently on the basis of the above statements we may reasonably argue the probable existence of different, though closely related, chemical varieties of karyoplasm as peculiar to the cell nuclei of individual organs and tissues.

Lilienfeld,[11] however, while accepting in a general way the views already expressed emphasizes the probability that as a rule there is a constant difference between the nucleus and the body of the cell, in that the former in every phase of life consists mainly of nuclein substances, *i. e.*, nucleo-proteids, nuclein and in extreme cases nucleic acid, while the body of the cell is composed mainly of pure proteids and nucleo-albumins with a low content of phosphorus. But as there are changing relations between these individual bodies, the tone of color obtainable by different dyes is obviously more or less variable; but as a rule, we may say that the nuclein-containing bodies of the nucleus have the strongest affinity for basic dyes, while the proteids of the cell body naturally seize hold of the acid dyes.

Further, Lilienfeld, who has recently made a thorough study of the inner structure of leucocytes and has named the characteristic constituent of the nucleus, *nucleo-histon*, describes this body as a nucleo-proteid, a body comparable to a chemical salt composed of a proteid base, histon, and a complex acid, leukonuclein, which in turn is made up of nucleic acid and proteid. So that in this the latest work in this direction that I am familiar with, we find results all bearing out the general statements just submitted.[12] Again, Lilienfeld has shown

[10] Halliburton

[11] Verhandlungen der Berliner physiologischen Gesellschaft. Du Bois Reymond's Archiv für Physiologie. Jahrgang, 1893, p. 391.

[12] Compare Lilienfeld "Zur Chemie de Leucocyten." Zeitschr. Phyiol. Chem. Band. 18, p. 473.

that it is the nucleic acid of the nucleus which is the primary cause of the pronounced color shown by this portion of the cell on treatment with aniline dyes.

With this understanding of the wide-spread distribution of nucleins throughout all animal and vegetable cells, let us consider somewhat more in detail the character of their decomposition or cleavage products, for this may give us a clearer insight into their general nature. As already stated, the nucleins thus far studied yield on treatment with dilute mineral acids a row of peculiar crystalline nitrogenous products, the xanthin bases so-called, the true antecedent of which Kossel has shown to be nucleic acid. Hence, the yield of these bodies, which, by the way, belong to the uric acid group, must depend upon the amount of nucleic acid contained in the given nuclein. The wide-spread distribution of these bodies, throughout the animal organism especially, wherever cell activity is pronounced, their close connection with uric acid and their evident origin in the nucleic acid of cell nuclei are facts of great physiological importance, since they throw possible light upon the physiological function of the cell nucleus and at the same time point to a genetic connection between the nuclein bases and uric acid. This phase of the matter, however, we cannot now consider, but there are one or two points connected with these nuclein bases that we cannot afford to pass by. First, the bases themselves are four in number, viz.: adenin, guanin, xanthin and hypoxanthin, all well defined bodies of known chemical constitution. Among these, adenin stands foremost. It is, to be sure, the one most recently discovered, but its characteristic chemical nature and constitution give it a peculiar prominence the others do not possess. It is not only a product of the chemical decomposition of pure nuclein by dilute acids, but it is widely distributed in nature, and its distribution in the organs and tissues of animals and plants corresponds to its genetic relationship to the characteristic constituent of the cell nucleus. Thus Kossel[13] has obtained it from the pancreatic gland and from the spleen, also from yeast cells and from tea leaves, but found it

[13] Zeitschrift für physiologische Chemie. Band 12, p. 241.

wanting in muscle tissue, poor in nuclei. F. Kronecker[14] found it in the spleen, lymph glands and kidneys of oxen, while Stadthagen[15] found it present in the liver and urine of a patient suffering from leukæmia, a disease in which the white blood cells are enormously increased in number. It is not to be understood, however, that the adenin exists wholly free in these cases. On the contrary, it exists in plant and animal tissues in loose combination, in part at least, with albumin and phosphoric acid. This combination is easily broken by the action of dilute acids, especially at 100° C., and also by spontaneous decomposition after death, *i. e.*, the adenin is an integral part of the nucleic acid which is present in all cell nuclei, and under certain conditions can be split off from the complex molecule of which it is an integral part.

In composition, adenin is peculiar in that it contains no oxygen. It is composed solely of carbon, hydrogen and nitrogen in such proportion as to warrant the conclusion that it is a polymer of prussic acid, HCN. It has in fact the same percentage composition as prussic acid, and its ready convertibility into potassium cyanide by fusion with caustic potash at 200° C., testifies to the close relationship between these two bodies. The existence of cyanogen compounds in the animal body has long been suggested as theoretically probable, and the finding of adenin gives to this hypothesis a substantial basis and points to the cell nucleus as the seat of these cyanogen compounds. Further, adenin is closely related to hypoxanthin, a body with which we are more familiar and whose origin we shall need to consider. Moreover, we find when we come to study relationships that all the so-called nuclein bases are closely related to adenin, as is seen from the following formulæ, which bring out the analogies quite clearly:

Adenin	$C_5H_4N_4$ NH	Guanin	$C_5H_4N_4O$ NH
Hypoxanthin	$C_5H_4N_4$ O	Xanthin	$C_5H_4N_4O$ O

Both adenin and hypoxanthin contain a peculiar chemical group $C_5H_4N_4$, called by Kossel and Thoiss[16] adenyl, and we

[14] Virchow's Archiv. Band 107, p. 207.

[15] Ibid. Band 109, p. 390.

[16] Zeitschrift für physiologische Chemie. Band 13, p. 396.

may consequently consider adenin as adenylimid, while hypoxanthin may be appropriately termed adenyloxide. As might be expected from the close relationship between these two bodies, adenin can be readily converted into hypoxanthin; and in a similar manner the allied base guanin can be transformed into xanthin. Thus, Schindler[17] finds by experiment that adenin dissolved in water and exposed to putrefaction at about 20° C. with exclusion of air, in time entirely disappears, a large amount of hypoxanthin appearing in its place and likewise a trace of xanthin. In other words, oxygen-free adenin is made by this process to combine with oxygen, being converted into the related oxygen-containing body hypoxanthin, with a giving up of ammonia. Guanin by a like method of treatment is changed into xanthin. The reactions involved are very simple as the following equations show:

$C_5H_5N_5$	+	H_2O	=	$C_5H_4N_4O$	+	NH_3
Adenin				Hypoxanthin		Ammonia
$C_5H_5N_5O$	+	H_2O	=	$C_5H_4N_4O_2$	+	NH_3
Guanin				Xanthin		Ammonia

We thus have every reason for believing that when hypoxanthin results from the breaking down of nuclein it passes through the intermediate stage of adenin. In other words, adenin is a primary cleavage product of nuclein, or rather of nucleic acid, while hypoxanthin is a secondary product coming directly from the adenin. In a similar manner, guanin is a primary decomposition product of nucleic acid, xanthin being in the same sense a secondary product. These four bases are plainly closely related and intimately associated in many ways, and all are alike cleavage products of the nuclein obtainable from cell nuclei. But the primary bodies adenin and guanin are evidently far more susceptible to the changes going on in living cells than their neighbors hypoxanthin and xanthin. All four, however, are capable of complete decomposition with formation of a variety of decompo-

[17] Zeitschrift für Physiologische Chemie. Band 13, p. 432.

sition products. In this connection, one of the most instructive series of changes adenin undergoes outside the body is that induced by long-continued warming with dilute hydrochloric acid, in which it is completely broken down into ammonia, carbonic acid, formic acid and glycocoll or amido-acetic acid. Xanthin and hypoxanthin furnish the same products by like treatment:

$C_5H_5N_5 + 8H_2O = 4NH_3 + CO_2 + 2H\text{–}COOH + CH_2\text{–}NH_2\text{–}COOH$
Adenin. Formic Acid. Glycocoll.

$C_5H_4N_4O + 7H_2O = 4NH_3 + CO_2 + 2H\text{–}COOH + CH_2\text{–}NH_2\text{–}COOH$
Hypoxanthin.

$C_5H_4N_4O_2 + 6H_2O = 3NH_3 + 2CO_2 + H\text{–}COOH + CH_2NH_2\text{–}COOH$
Xanthin.

Again, adenin can be easily decomposed completely into carbonic acid and ammonia, but the most striking fact in connection with this body, as already stated, is its easy convertibility into cyanide of potash, indicating as it does the close relationship existing between this substance and the cyanogen group.

In attempting to ascribe a function to adenin that shall correspond to the accepted function of the cell nucleus, we must have proof that this substance, under conditions which obtain in the body can readily pass into new forms easily capable of undergoing reactions. As has been shown by experiment, the conditions for vigorous reduction processes are present in every cell. Reduction gives a blow by which the oxygen-free adenin may be transformed into a new body having a strong avidity for oxygen, and which may in turn be transformed through the laying on of more molecules into a body resembling, if not identical with, azulminic acid. Adenin, for example, dissolved in dilute hydrochloric acid and treated with zinc is quickly decomposed by the reducing action of the nascent hydrogen evolved into what is evidently azulminic acid $C_4H_5N_5O$, a derivative of dicyan. If dicyan $\begin{matrix} CN \\ | \\ CN \end{matrix}$

is simply dissolved in water and allowed to stand exposed to the air for a long time, the solution gradually becomes dark in color, accompanied by a dissociation in which formic acid, prussic acid, oxalate of ammonia and urea result, together with a certain amount of azulminic acid; reactions which again emphasize the cyanogen-like character of the adenin molecule.

Such being the nature of adenin, it is not to be doubted that bodies emanating from this substance with strong affinities must be important actors in the physiological and chemical processes, especially those of a synthetical order, going on in all cellular tissues. In this connection it is to be remembered that Pflüger on purely theoretical grounds ascribed great importance to the physological rôle played by the cyanogen group with polymerization, etc., in the living albumin molecule. Dead albumin, such as we see in the white of egg, blood-fibrin, etc., is a comparatively stable substance, indifferent to neutral oxygen, not readily prone to change, and yielding decomposition products by no means identical with the cyanogen-like bodies resulting from normal proteid metabolism.[18] Evidently then the dead food-albumin in being assimilated is reconstructed on a different plan, the atoms are rearranged and in the living albumin molecule, as in the protoplasm of the cell, we are lad to infer a close union of the carbon and nitrogen with formation of the comparatively unstable cyanogen group. In the dead protoplasm, on the other hand, the nitrogen of the proteid is joined directly with hydrogen to form amidogen (NH_2), but in the processes of anabolism going on in all living cells, the nitrogen is detached from the hydrogen and made to combine more directly with carbon to form the more unstable group CN. As a result, the katabolic products of proteid metabolism known to us are the cyanogen-containing bodies, guanin, uric acid, creatin and the related body urea. These are products of the katabolism of living protoplasm, and in the discovery of adenin and its close relationship to the typical xanthin bases we have added proof of the existence of cyanogen-containing radicals in the protoplasm of the cell, especially in the karyoplasm of the nucleus. In all of these xanthin

[18] See Drechsel, however, Der Abban der Eiweissstoffe. Du Bois Reymond's Archiv, 1891, p. 248.

bodies there is to be seen a peculiar combination of carbon, nitrogen and hydrogen such as is not found in dead proteid matter. The structure of the molecule is different and is emblematical of a still more complex molecule in which the atoms are similarly arranged.

Thus, it is to be remembered that whenever an organ rich in cells is decomposed by dilute acid, adenin, guanin, xanthin and hypoxanthin are never obtained alone. They are not found as individuals, but in every tissue which has retained its original condition, the two special xanthin bases, for example, are found in combination with other groups of atoms, especially with phosphoric acid and albumin, as parts of a higher compound, the nuclein. From this higher compound, the individual components cannot be extracted by simple solvents or other like methods of isolation; a blow must be struck by which the complex molecule shall be shattered and the individual parts liberated, as by the action of a dilute mineral acid. In tissues very poor in nuclear elements, on the other hand, as in muscle tissue, we find only the decomposition products of nuclein; the chemical union between the individual fragments is broken, and the phosphoric acid, for example, no longer exists in organic combination, but as soluble alkali phosphates. In a similar manner, the xanthin and hypoxanthin exist in a free condition capable of extraction by water alone.

Further, in the transformation of adenin and guanin into hypoxanthin and xanthin respectively, with a splitting off of the NH group and the acquisition of oxygen we have a possible illustration of the manner in which the migration of the amidogen group of albumin to urea takes place; a transformation which no doubt goes on in the tissues and perhaps in every cell nucleus.

Certainly then in the light of what has been said, the cell nucleus may be looked upon as in some manner standing in close relation to those processes which have to do with the formation of organic substances. Whatever other functions it may possess, it evidently, through the inherent qualities of the bodies entering into its composition, has a controlling

power over the metabolic processes going on in the cell, modifying and regulating the nutritional changes.[19] And you will notice that I lay great stress upon the chemical nature of the karyoplasm, the inherent qualities of the plasm as indicated by its molecular condition. It is not the mere fact that the karyoplasm is housed, so to speak, in a certain definite structure that it is possessed of its characteristic qualities, but the qualities are peculiar to the living molecules themselves. The living molecules are different from the dead molecules because they have a different chemical constitution, the atoms are arranged in a different manner. All this being true we can easily see how cells devoid of specific nuclei may perhaps be functionally active, to a slight extent, provided they contain the same chemical groups in the cytoplasm.

But I have already exceeded the alloted time, while there is much that might be said. Still, the foregoing will indicate in a limited way that there is a field of work in connection with the chemistry of the cell that cannot consistently be ignored in biological inquiries.

[19] Compare M. Verworn, "Die physiologische Bedeutung des Zellkerns." Pflüger's Archiv f. Physiol. Band 51, p. 1.

THE CLASSIFICATION OF THE ARTHROPODA.

By J. S. Kingsley.

In the concluding section of my paper on the Embryology of Limulus ('93), I expressed my views upon the classification of the Arthropods. The following is to be regarded as an expansion of the remarks I then made, with the inclusion of some matter not then available.

Since the days of von Siebold ('46), the naturalness of the group of Arthropoda has been almost universally recognized, only a few, like the present writer ('83) and von Kennel in his recent text-book of Zoology ('93), appearing to doubt the homogeneity of the division. On the other hand, the way in which the Arthropoda should be subdivided has been very differently regarded by different authors. Space will not permit an extended résumé of the growth of our knowledge, but it is fair to say that almost every person treating of the subject has added materially to the basis for a natural classification, either by the discovery of new facts or by throwing new light upon facts known before. At present, the great majority of naturalists divide the Arthropod phylum into two groups or sub-phyla, which, however named, are essentially Branchiata and Tracheata, the former embracing the Trilobites, Eurypterids, Hemiaspids and Xiphosures, along with the true Crustacea; the latter containing the Onychophora (Peripatus) Myriapods, Hexapods and Arachnids.

Yet this division is not universally accepted, and a few years ago, Professor E. Ray Lankester, following out the earlier suggestion of Strauss-Dürckheim and the later one of the younger van Beneden ('71), demonstrated that the affinities of Limulus were with the the Arachnids rather than with the Crustacea. This epoch-making paper—"Limulus an Arachnid"—must form the basis of all farther studies of Arthropod taxonomy, since it logically follows from his conclusions that the distinctions made between Branchiata and Tracheata are physiologi-

cal rather than morphological, and that their emphasis tends to obscure true relationships upon which alone a natural system can be based. Since Lankester wrote, most students of Arachnid morphology and every one (excepting Professor Packard) who has investigated the structure or ontogeny of Limulus, have endorsed the general conclusion that Limulus is closely related to the Arachnids.

This being the case, Lankesters's later views upon the subdivision of the Arthropoda possess a peculiar interest. In the ninth edition of the Encyclopedia Britannica, article "Zoology," he gives the following arrangement:

Branch Arthropoda.
  Grade 1, Ceratophora.
    Class I, Peripatidea.
    Class II, Myriapoda.
    Class III, Hexapoda.
  Grade 2, Acerata.
    Class I, Crustacea.
    Class II, Arachnida.
    Class III, Pantopoda,
    Class IV, Tardigrada.
    Class V, Linguatulina.

Professor Claus is apparently not so radical in his ideas. I fail to make out from his various polemical articles ('86 [a, b], 87 [a]) exactly what his later views are, but in the fourth edition of his Lehrbuch ('88)—the fifth edition is not at hand—there is such a lack of regularity in the subordination of type, headings, etc., that it is difficult to ascertain his opinions. As I interpret him, he has the following scheme:

Arthropoda.
  Class 1, Crustacea.
    Sub-Class I, Entomostraca.
    Sub-Class II, Malacostraca.
    Gigantostraca.
      Merostomata.
      Xiphosura.
  Class II, Arachnoida.
  Class III, Onychophora.

Class IV, Myriapoda.
Class V, Hexapoda.

From this it would seem that the only conclusions which can be drawn are that, at least at this date, Professor Claus regarded the Gigantostraca as a subdivision of the Crustacea, but was uncertain whether to regard it as equivalent to the Entomostraca and Malacostraca or not.

It is impossible to give the views of Hatschek, as the part of his "Zoologie" treating of the Arthropods has not yet appeared. In his general table ('88, p. 40) he accepts, in a modified way, the Articulata of Cuvier, and regards the Onychophora as a class, of equal rank with the Arthropoda.

The earlier studies of Boas upon the classification of the Crustacea possess such value that his general ideas upon the subdivisions of the Arthropoda deserve mention. In his "Zoologie" ('90) he adopts the following arrangement:

Arthropoda.
I Class, Crustacea.
I Sub-Class Entomostraca, including as Orders: I, Phyllopoda; II, Cladocera; III, Xiphura (*sic*); IV, Trilobitæ; V, Ostracoda; VI, Copepoda; VII, Cirripedia.
II Sub-Class, Malacostraca.
II Class, Myriapoda.
(Peripatus doubtful.)
III Class, Insecta.
IV Class, Arachnida.

Lang ('88) has the following classification:

Arthropoda.
I Sub-Phylum, Branchiata.
Only class Crustacea.
First "Anhang to Branchiata—Trilobita, Gigantostraca, Hemiaspidæ, and Xiphosura.
Second "Anhang"—Pantopoda.
II Sub-Phylum, Tracheata.
I Class, Protracheata.
II Class, Antennata (Myriapoda and Hexapoda).
III Class, Chelicerotæ *sive* Arachnoidea.
"Anhang" to Arthropoda—Tardigrada.

Fernald has approached the subject from the standpoint of Hexapod morphology. He gives ('90) a phylogenetic tree in which two main trunks arise from the primitive unsegmented worm. One of these embraces the Annelids and Peripatus, the other includes the Arthropods proper. This latter branches into the Hexapods and the Crustacea, the Arachnids and Limulus being represented as offshoots from the main Crustacean line. The origin of the Myriapods is left in doubt, but of the two divisions the Chilopods are represented as an offshoot from the Diplopod stem.

Richard Hertwig ('92) adopts the following scheme:

Branch Arthropoda.
- I Sub-Phylum, I Class, Crustacea.
  - 1 Sub-Class, Entomostraca, containg as regular members the Orders: I, Copepoda; II, Branchiopoda; III, Ostracoda; IV, Cirripedia; and, as "Anhangen," V, Xiphosura; VI, Trilobitæ; VII, Gigantostraca.
  - II Sub-Class, Malacostraca.
- II Class, Onychophora.
- III Class, Myriapoda.
- IV Class, Arachnoida (including Pantopoda as an "Anhang").
- V Class, Hexapoda.

Lastly, von Kennel, whose studies on Peripatus entitle his views on Arthropod taxonomy to a hearing, denies ('93) the validity of the group Arthropoda, claiming that those features which would seem to unite the Tracheata and Branchiata are either superficial or are common to the whole series of metameric Invertebrata. He places the Xiphosura among the Crustacea, apparently regarding them as equivalent to the rest of the group. The Tracheata are divided into three sub-classes, Myriapoda, Hexapoda and Arachnoida, the relationships of Tardigrada and the Pycnogonida being regarded as uncertain.

My own views, as stated in my last paper on Limulus, have not undergone any extensive modification, although the tabular statement has undergone some slight changes. Chief of these is the transfer of the Trilobitæ from a position of uncertainity to a more close union with the true Crustacea, a matter

which will be referred to again below. I would now present the following scheme:

Phylum Arthropoda.
- Sub-Phylum I, Branchiata.
  - Class I, Crustacea.
    - Sub-Class I, Trilobitæ.
    - Sub-Class, II, Eucrustacea.
  - Class II, Acerata.
    - Sub-Class I, Gigantostraca.
    - Sub-Class II, Arachnida.
- Sub-Phylum II, Insecta.
  - Class I, Chilopoda.
  - Class II, Hexapoda.
- Sub-Phylum III, Diplopoda.

Incertæ Sedes—
- Pycnogonida.
- Linguatulina.
- Pauropoda.
- Tardigrada.
- Malacopoda.

The various papers by Lankester, McLeod, Laurie and myself have, I think, clearly shown that the older grouping of the Arthropoda into Branchiates and Tracheates is not justified by the facts of structure and ontogeny; that tracheæ are not homologous structures in all Arthropods which possess them, and that the old group of Tracheata is polyphyletic in origin. Since classification must represent the various lines of descent, the old must therefore go. There remain many points which must be investigated anew, but I feel confident that further research will support, in its main features, the classification adopted above, and considered more *in extenso* below.

PHYLUM ARTHROPODA.

I am not prepared to discuss the validity of this group, although for reasons that will appear below, I am inclined to believe the great divisions which I recognize are but remotely related to one another, and it may yet be proved, as I suggested several years ago ('83), and as von Kennel believes, that

they have no common ancestor nearer than the Annelids. The jointed nature of the appendages offers no insuperable objection to this view, while the early phases of the egg, the formation of the germ layers, the structure of the alimentary canal, the morphology of the reproductive and excretory organs, as well as certain facts concerning the circulatory, respiratory and nervous systems are easiest explained upon such an hypothesis. The presence of compound eyes in branchiate and tracheate forms would, at first thought, be a strong argument for the older views, but these organs differ so greatly in their structure that it is easier to regard them as homoplastic organs (comparable in a way to the eyes of Cephalopods and Vertebrates) rather than as derivatives from a common compound ancestral visual organ. For our present purposes, the group of Arthropoda may be retained as a convenient assemblage, characterized in the following manner: Heteronomously segmented animals, with, typically, a pair of appendages to each somite; the whole enclosed in a chitinous segmented exoskeleton, the jointing of which extends to the appendages, thus justifying the term Arthropoda. The appendages, primitively locomotor in function, may be modified, on one or more somites, for the taking or commuting of food, for respiration, copulation, oviposition, sensation, fixation, etc. No circular layer of muscles in body wall; nervous system consisting of a pair of primitively supraœsophageal ganglia and a ventral chain of paired ganglia, of which one or more pairs may, in the course of development, be transferred to the prestomial region. Eyes, simple, aggregate, or compound, with, in some cases, an inversion of the retinal layer. Cœlom small, inconspicuous; circulatory organs consisting of a dorsal heart enclosed in a vascular pericardial sac; blood-vessels more or less evidently metameric, terminating in "lacunar" spaces. Respiration, either by the entire surface of the body or by specialized outgrowths or involutions of the same. Excretion, either by true nephridia or by Malpighian tubules, developed from either the mid- or the hind-gut. Reproductive organs consisting of gonads developed from the cœlomic walls and with modified nephridia serving as efferent ducts.

In order that we may compare, part with part, the different forms of Arthropods, it becomes necessary to assume some basis of comparison, and apparently the only one available is that of the exact homology of the similarly situated meta meres in the different groups, but here we meet with a difficulty. How can we be certain, for example, that somite 10 of the lobster is the exact homologue of somite 10 in the beetle? How can we tell that no somite has been lost in the evolution of these different lines? Perfect certainty is impossible, and we now know that in the serial comparisons of not more than five years ago, errors crept in, because there is a tendency of somites to become aborted or obsolete. This tendency is well-known in cases of Apus and Oniscus, where one of the anterior pairs of appendages is greatly reduced; and in Limulus, Scorpions, Moina, etc., where an anterior somite is not differentiated until after those behind it. In many forms there is an obliteration or a fusion of cœlomic cavities in the anterior region, the mesoderm flowing together as a common mass.

On the other hand, the embryonic phases of the nervous system seem to give clear indications of neuromeres in the anterior end of the body, and, as farther back, neuromeres correspond to the mesodermic metameres, it is reasonable to accept until error be shown, a somite for each neuromere at the anterior end of the Arthropod body. Unfortunately, we have detailed knowledge of these neuromeres in but few cases, and even in these there is a lack of uniformity in the observations.

In the Hexapods it has been shown that the "cerebrum" of the adult is composed of at least three pairs of ganglia called by Vaillanes, respectively, the protocerebrum, the deutocerebrum and the tritocerebrum. These elements have been recognized by Tichomiroff in the silkworm (teste Cholodkowsky) in Acilius (Patten, '88), in Blatta (Cholodkowsky, '91), in Mantis (Vaillanes, '91), in Xiphidium and Anurida (Wheeler, '93), while Carrière ('90) has described *four* cerebral elements in Chalicoderma. The figures of the latter author do not seem to me conclusive, and I am inclined to believe the more numerous observations in this difficult field as the more probably correct.

These cerebral elements apparently have different values. So far as observations go, the protocerebrum is always preoral, and in no case is any appendage developed in connection with it. Apparently, the region in which it occurs is to be compared to the preoral lobe of the annelids, while the two ganglia of which it is composed would correspond to the "Scheitelplatte" of German embryologists. The other cerebral elements, on the other hand, are primitively behind the stomodæum, and, in some forms at least, an appendage is developed in connection with each. Thus the antennæ belong to the deutocerebral neuromere, while in Anurida Wheeler has shown that the tritocerebral neuromere possesses at an early stage a pair of small appendages, which here, as in all Hexapods, is absent from the adult.

In the Crustacea, not a few observations go to show somewhat similar conditions. We find there a protocerebrum without appendages at any stage, followed by a series of ganglia which present many claims to belong to the postoral series. In a paper on the Embryology of Crangon ('89), I claimed that in that form the antennæ were primitively postoral, but since the validity of my observations have recently been questioned by Weldon ('92) and Herrick ('92),[1] they must be repeated before they can be accepted. Aside, however, from these questionable observations, there are many other facts which go to show that the antennal neuromeres belong to the the postoral rather than to the prestomial series. There is, however, less evidence for this position for that pair of ganglia which exist in the lobster (see Bumpus ('91), pl. XVII, fig. 1), between the protocerebral ganglia and the neuromeres of the antennæ. It is without appendages, and although its fate has not been traced, it probably becomes fused in the "cerebrum" of the adult.[2] This neuromere is, I am inclined to think, also to be regarded as belonging to the same series as that of the antennæ.

[1] For some remarks upon these criticisms, see my paper ('93), p. 235, foot-note.

[2] Professor J. P. McMurrich informs me that he has found these deutocerebral ganglia in the various Isopods (Jæra, Oniscus, Porcellio, Armadillidium, etc.) which he has studied.

In the Arachnids and the Xiphosures, we have evidence of several elements in the "brain." Both Patten and myself have shown the existence of three pairs of cerebral ganglia in Limulus, in front of the ganglia of the first pair of appendages. Patten finds ('90) the same number in the brain of the Scorpion, as do Locy ('86, pl. XI, fig. 70) and Kishenouyi ('90) in Agalena. The copies of Morin's figures given by Korschelt and Heider ('92, fig. 383 B) seem also to be in full harmony. On the other hand, Schimkewitsch (87, pl. XXI, fig. 3) represents two pairs of ganglia in Epeira in front of the ganglia of the first pair of appendages, while in the diagrammatic figure (pl. XXIII, fig. 5) he apparently indicates four pairs of preappendicular ganglia.

In other groups of Arthropods I know of no detailed observations which can be used to aid in the enumeration of the neuromeres in the anterior region of the body. If we assume that in the cases of Hexapods, Crustacea, Xiphosures and Arachnids, the neuromeres enumerated above represent the total somites in this region, we may then compare, somite by by somite, these groups in the following manner:

	Hexapod.	Arachnid.	Xiphosure.	Crustacea.
Neuromere I	No Appendage	No Appendage	No Appendage	No Appendage
" II	Antenna	No Appendage	No Appendage	No Appendage
" III	Appendage	No Appendage	No Appendage	Antennula
" IV	Mandible	Chelicera	1st Leg	Antenna
" V	Maxilla	Pedipalpus	2d Leg	Mandible
" VI	Labium	1st Leg	3d Leg	Maxilla 1
" VII	1st Leg	2d Leg	4th Leg	Maxilla 2
" VIII	2d Leg	3d Leg	5th Leg	Maxilliped 1
" IX	3d Leg	4th Leg	6th Leg	Maxilliped 2

Of course it will be understood that this grouping is limited by our present knowledge, and that at any time discoveries may be made which will overturn it. It is, however, to be noted that it brings the hinder margins of the thorax of the Hexapoda and of the cephalothorax of Limulus and of the

Arachnids into exact correspondence. In the case of the Crustacea the corresponding line passes behind the third maxilliped of the Decapod.

If it should, however, be shown (as many believe) that the Crustacean metastoma has its own somite, the line will be thrown forward to behind the second maxilliped, and it will correspond to the line of division between the head and thorax of the Edriophthalmia.

Since the older ideas of numerical sequence are better known, I have used them in the following discussion rather than that based upon the neuromeres. Thus in the Hexapods somite (or appendage) I=Neuromere II; in the Arachnid and Xiphosures somite I = Neuromere IV; in the Crustacea somite I = Neuromere III.

The morphology of some other organs call for a moments' consideration. Prominent among these are the vasa Malpighii. These are usually regarded as characteristic of the "Tracheates," and their presence in the Arachnids has been adduced as a strong argument for their association with the Hexapods. It has been, however, pretty conclusively shown that these organs are not homologous throughout the Arthropod phylum, for in the Hexapod they are derived from the hind-gut, and are therefore ectodermal, while in the Arachnida, as Loman ('86–7) has shown, they are derivatives of the mesenteron and are consequently entodermal. Their similarities are those of homoplassy rather than of homology, and the only argument that can be drawn from the occurrence in these forms is that Arachnids and Hexapods are not closely related. Similar organs with similar functions have been described in various Edriophthalmia, but we are yet in doubt as to their origin. The studies of Spencer ('85) represent them as without chitinous intima in the Amphipods. They may, therefore, be entodermal. A detailed study of the region of the hind-gut of certain Decapods might give results interesting in this connection.

The tracheæ furnished another instance of homoplassy. These organs furnish the chief ground for the group called "Tracheates," since in most they form the sole means of res-

piration. Yet these are, in the opinion of many, not homologous. In the Hexapoda they arise, ontogenetically, as inpushings of the ectoderm of sides of the body, outside and above the line of the insertion of the limbs. Their method of growth, the general structure, etc., all point to their origin, as was pointed out by Chun ('75) from dermal glands which later assumed respiratory functions. The tracheæ of the Arachnids, on the other hand, have had a different origin. In those forms in which they have been studied, they arise as inpushings behind the temporary appendages on the abdomen. There is not a little evidence to show that they have arisen from gills borne on the posterior surfaces of these appendages, as in the Limulus of to-day; that they have been pushed into the body, taking the form of lung books, a condition permanent in all the respiratory organs of the Scorpions and in those of one or two somites of the Araneina; and then, coincidently with a reduction in the circulatory organs, they have penetrated farther and farther into the body. For the details of this process, as well as for the wonderful histological similarity between the embryonic gills of Limulus and lungs of Arachnids the reader is referred to my full paper. The "spiral threads" in the two cases are to be explained as mechanical in origin—corrugations give greater strength without excessively thickening the intima. Still, a third type of "trachea" is to be be found in the gills of the Oniscid Crustacea. These organs have become adapted for aerial respiration, and, in connection with this change, the organs have been permeated by branches of minute tubes, lined with a chitinous intima, produced by inpushings of the outer body wall. These tracheæ cannot be regarded by the strongest advocate of the naturalness of the "Tracheates" as homologous (*i. e.*, homogenous) with those of the Hexapods. I have made a number of, as yet unpublished, observations on these organs in Porcillio. Leydig described them in detail some years ago ('78). The peculiar structures in the genus Tylos as described by Henri Milne-Edwards ('40, p. 187–8) should be considered in this connection.

It is only recently that the existence of nephridia in the Arthropoda has been placed beyond a doubt. The earlier students

of the shell gland of the Entomostraca often made comparisons between it and the "segmental organs" of the Annelids, but the trouble was that the former terminated blindly internally, while in the Annelids the organ formed a tube connecting the body cavity (cœlom) with the interior. The problem was solved by Sedgwick ('88), who showed that in Peripatus the nephridia were closed internally, but that they were still nephridia as proved by development, and that we have here to deal with a greatly diminished cœlom. In the light of these facts it is now placed beyond a doubt that in the antennal and shell glands of the Crustacea, and in the coxal glands of Arachnids and Limulus, we have true nephridia.[3] In all there is the formation of a cœlom, a division of the cœlom of certain somites into dorsal and ventral moieties, and a development of the lower portion into end sac and nephridial tube, the latter portion breaking through to the exterior.[3]

Following the discoveries by Sedgwick that the genital ducts of Peripatus were modified nephridia, came the observations of Heymons ('90), Cholodkowsky ('91) and Wheeler ('93), all of which show that exactly the same conditions exist in the Hexapods, while Laurie ('90) has demonstrated that it is at least probable that the same holds true for the Scorpions. I made no observations on the origin of the genital ducts of Limulus, and I do not recall any account of their development in the Crustacea. In the latter group, however, there is not a little evidence of an anatomical character which is easiest interpreted upon the same hypothesis. There these ducts are metameric, and may occur in different somites in the different sexes. This condition is to be explained in two ways, as has previously been pointed out by Lankester. Either the ducts are to be regarded as new formations, or they are previously existing structures modified for reproductive functions exclusively. That this latter is the case, and that the ducts are nephridial is rendered probable by the following considera-

[3] These organs have been shown beyond a doubt to be mesodermal by Grobben ('79 , Kingsley ('89, '90 and '93), Kishenouyi ('91), Lebedinsky ('92), Laurie ('90), etc., and yet Bernard ('93), with these facts available, has recently attempted to derive these structures from the glands of annelids—ectodermal structures—ignoring the facts presented by those who have actually investigated the subject.

tions: In all metameric animals one or more pairs of nephridia serve as genital ducts, and no case is known of the formation of new outlets. The genital ducts are so related to the gonads and these latter to the cœlom, at least in the Decapods (*cf.* Weldon, '89, '91) that we must regard the genital epithelium as cœlomic, and the ducts as ventral diverticula of the same space.

The salivary glands afford some difficulties, for they occur in most "Tracheates," and are usually stated to be absent from the "Branchiates." This apparent difference between the two groups is possibly to be explained by the different method of life—aquatic in the latter, terrestrial in the former. It is, however, to be noted that salivary glands have been recognized in Astacus (*cf.* Lang, '89, p. 344), while renewed studies must be made of the so-called salivary glands of the Arachnida before we are certain of their homology with those of the Hexapods. Several organs which have been called salivary glands among the spiders and their allies have been shown to be coxal glands (*i. e.* nephridia) or poison glands, and it is possible that all of these organs may have different homologies than those indicated by the name usually applied to them.

A group of structures which cannot, as yet, be discussed, is that of the embryonic membranes. In the Scorpions as in the Hexapods, the embryo develops those as yet unexplained fœtal membranes which so closely simulate those of the higher vertebrates. It may be that here, as in other places, we have similar but not identical organs. The accounts of their development in the Arachnids by Metschnikoff, Kowalevsky and Schulgin, and Laurie differ considerably, and, until we know something of the ancestry and real meaning of the structures which are united under this head we cannot be certain of the taxonomic value to be placed upon them. It may be noted here that the structures described by Bruce ('87) as occurring in the spiders are, in all probability, not amnion and serosa, but either invaginations in connection with the brain or the inpushing to form the median eye.

Sub-Phylum I—Branchiata.

Arthropods breathing by means of gills (or lungs or tracheæ modified from gills) developed in connection with the appendages; without distinctly differentiated head, with long stomodæum, nephridia persisting in somite II or V (or both), genital ducts opening near the middle of the body. Anterior appendages all multiarticulate, the basal joints of one or more pairs serving as organs of manducation. A chitinous entosternite and deutova frequently present.

I hardly think it necessary, each time the limits of a group are changed, to give the new combination a new name. Our nomenclature is already cumbersome enough, and the slight indefiniteness is vastly preferable to the confusion of the other course. I have, therefore, retained the term Branchiata for the enlarged group, since I regard the lungs and tracheæ of the Arachnids as but modified branchiæ. In only the Edriophthalmia and certain Phyllopods do we have a distinctly differentiated "head," and the head in these groups is not the same in its limits. Under the head of nephridia I include the antennal and shell glands of the Crustacea and the coxal glands of the Arachnids and Limulus. The former have been shown by numerous observers to be true nephridia, while the observations of Laurie ('90) and Lebedinsky ('92), Sturanay ('91), are conclusive to the Arachnids. The observations of Gulland ('85), Kishenouyi ('91) and myself ('85 and '93) would seem to settle the matter in the Horse-shoe crab.[4] That the genital ducts are to be regarded as modified Nephridia has already been shown. Their position is inconstant in the Crustacea, varying in some forms with the sexes of the same species. In some of the more reduced forms, as the cirripeds, they are apparently almost terminal, a condition to be explained by the

[4] In my first paper on the development of Limulus, I pointed out that the coxal glands of Scorpio and Limulus were apparently homologous with the shell gland of the lower Crustacea, since in both cases they open at the base of the fifth pair of appendages. This identification is apparently not pleasing to Professor Claus ('86, since he has seen fit to ridicule my ideas of homology. I confess that I do not understand his objections, and certainly the evidence derived from the neuromeres (admitting one for metastoma of the Crustacea—*cf.* Brooks, '82), seems fully to support my thesis.

small number of metameres that become differentiated. Other features which are common to most Branchiates, but which either are not common to all or are at the same time common to some of other groups, will appear below. It must, of course, be understood that in the above diagnosis of the group, features of internal anatomy are known only of recent forms; of the visceral structure of the trilobites, we are absolutely in the dark.

Class I—Crustacea.

Branchiate Arthropoda with functional gills; with one or two pairs of distinctly preoral appendages (antennæ) the first being purely sensory; the ganglia corresponding to these appendages being fused with the protocerebrum to form the "brain;" the appendages with typically a basal joint giving rise to two or three branches; several pairs of appendages modified for eating; alimentary canal with long œsophagus and well-developed stomodeal "stomach," mid-gut region short, the mid-gut glands ("liver") being well-developed; proctodeum long.

In all living Crustacea (Eucrustacea), there are two pairs of antennæ, although in some forms (e. g., Apus, Oniscids) one or the other pair has has become greatly reduced. In the Trilobites, on the other hand, but a single pair has, as yet, been discovered. It therefore remains to be shown whether a single pair is characteristic of these forms, or whether we have here a possibly greatly reduced additional pair. In case the former alternative prove true, it may be necessary to remove the Trilobites completely from the position here assigned them, though it will not necessarily follow that they should be associated with the Eurypterids and Limulus. (For the position of the Trilobites, see below).

It is difficult to say exactly what weight should be given the so-called "typical Crustacean limb," the di- or trichotomous appendage so frequently met with in this class, and which is not infrequently regarded as diagnostic. That this condition is a derivation of the lamellate condition found in Apus, as maintained by Lankester ('81) admits of little doubt, and

hardly more doubtful is the view which would compare the Phyllopod appendage with the Annelid parapodium. But two- and three-branched appendages are not unknown outside the Crustacea. One of the arguments advanced in favor of a Crustacean position for Limulus is that the abdominal appendages in that form are two-branched, while numerous observers have recorded a biramous condition in the appendages of the young of various "Tracheates." Among others we would mention the biramous pedipalps in Dendryphantes recorded by Croneberg ('80), the biflagellate antenna of an Indian Lepisma, and of an embryo *Blatta javanica* by Wood-Mason ('79), the bifid condition of the antenna of Blatta by Wheeler ('89), while Patten ('84), in the same form, describes the maxillæ and labium as "formed respectively of two and three branches, the second maxillæ thus attaining the typical trichotomous structure of the Crustacean appendages." Similar observations have been made upon other Hexapods, while in the Pauropida the trichotomous antennæ are to be called to mind.

Fully as characteristic is the extreme reduction of the entodermal portion of the alimentary canal proper, the entoderm cells being largely confined to the liver or mid-gut gland, while the canal itself is almost entirely composed of stomodeal and proctodeal invaginations (*cf* Kingsley, '89, pp. 13-19).

Sub-Class I—Trilobitæ or Palæocarida.[5]

Fossil Crustacea with tri-regional body—head, thorax, pygidium, all bearing appendages. "Head" unsegmented, with one pair of antennæ and with four pairs of postoral appendages, all pediform and with basal points manducatory. Thoracic somites indefinite in number, each bearing a pair of biramous (exopodite and endopodite) appendages, each appendage provided with a straight or curiously coiled gill (?). Pygidium segmented, with appendages beneath.

For several years I have maintained that the Trilobites had but the most distant affinities with the Xiphosures (e. g., '85, p. 555).

[5] This term was introduced by Packard ('79) for Limulus, the Trilobites and the Eurypterids. Later ('86), with no apparent reason, he dropped this term and substituted for it Podostomata. The two groups, as he limits them, are exactly the same.

In my latest paper ('93, pp. 252–254) I repeated the same ideas, and, within a short time of this paper, appeared Mr. Matthew's notice ('93) of the existence of true Crustacean antennæ in these forms. This, combined with the truly Crustacean thoracic appendages already described by Wolcott ('81 and' 84), and the utter inability, upon careful analysis, to homologise the regions in Limulus and the Trilobites, is sufficient to divorce the two and to assign the latter to the Crustacea.

Exactly what position they should occupy here is uncertain. It is undeniable that they present a superficial resemblance to the Isopoda. In both there is the same depressed body, the division of this into the three regions of head, thorax and abdomen, the head in both cases bearing sessile compound eyes; but at this point the resemblance ceases. In the Isopod the thorax is always 7-jointed; in the the Trilobites the number varies very considerably. In the Trilobites the appendages, as restored by Walcott, surround the mouth, much as in Limulus or the Scorpions; in the Isopods the arrangement is truly Crustacean. In the Isopods, in the embryo, as well as in the adult, the thoracic appendages consist of but a single branch, and when any other structures are present, as for instance, the plates forming the brood-pouch, these are placed mediad to the insertion of the limb; the gills (?) in the Trilobites are outside the point of articulation, while the limbs, as already stated, are dichotomously branched. In the Isopods the respiratory organs are lamellar appendicular plates beneath the abdomen; we do not know exactly what structures are found here in the Trilobites. Professor Mickleborough ('83) thinks that there are lamellar plates, but Mr. Walcott ('84) studying the same specimens believes that the appendages of this region resemble those of the thorax.[6] So it would appear that the Trilobites have no close affinities with the Isopoda; the resemblances to the Amphipods are even less close. So far as I am aware, there is no recent Crustacean which presents any resemblance to Trilobites closer than those of the Edrophthalmia just discussed, and yet we

[6] The process cuts illustrating Mr. Matthew's article gives no intelligible details of the foot structure in Triarthrus.

must consider these forms considerably removed from the primitive Crustacean stock, which, in the opinion of many, was not far removed from the modern Phyllopoda. Both types are well differentiated in the lower Cambrian, and no fossils as yet discovered serve to bridge the gap between the two. Nor does the little known of Trilobitan embryology throw any light upon the question. In some there is an apparent close similarity to the early stages of Limulus, but this may easily be explained upon the general principles of Arthropod growth. Thus, in Sao, as described by Barrande ('52), in which the resemblance to the Xiphosures is most marked, we have but that increase in the number of somites from a posterior budding zone common to most Arthropods, while in Trinucleus (Barrande) there seems to have been an acceleration in the development of cephalic and pygidial regions, and then, later, an increase in the number of thoracic segments in that manner so familiar in the development of the Decapoda. The resemblances to Limulus all lie in the depressed body form and the union of the anterior somites.

(*To be continued.*)

THE RANGE OF CROSSBILLS IN THE OHIO VALLEY WITH NOTES ON THEIR UNUSUAL OCCURRENCE IN SUMMER.

By A. W. Butler.

Loxia curvirostra COMMON CROSSBILL.

In 1838, Dr. Kirtland had not met with the American Crossbill (*Loxia curvirostra minor*) in Ohio or Indiana. Dr. Haymond omitted it from his "Birds of southeastern Indiana" in 1856. Dr. Wheaton reported it from Ohio in the winter of 1859–60. Evidently it was quite well known to Dr. Haymond in 1869. The winter of 1868–9, they were very abundant in the vicinity of Cincinnati (Dury). This was doubtless the case at other places also. The range of the species at this time was supposed to be northern North America, south in the Appalachian Mountains into Pennsylvania, extending in winter, irregularly over much of the United States. A letter from Mr. C. E. Aiken of Salt Lake City, Utah, informs me that this species became very abundant in the city of Chicago in July and August 1869, and remained until late in the fall. They fed greedily upon seeds of sunflowers and were so sluggish that one could approach within a few feet of them, so that they fell an easy prey to boys with catapaults. In the latter part of August of the same year, he found them common in Lake County, Indiana. He also notes that they were not rare the succeeding year in the vicinity of Chicago.

Dr. F. W. Langdon notes the capture of a single specimen from a flock of six or eight at Madisonville, near Cincinnati, Ohio, Nov. 30, 1874.

In the winter of 1874–5, Mr. Eugene P. Bicknell noted these birds were present in the lower Hudson Valley, and in April of the latter year found their nest. In the same article is noticed the occurrence of the species about New York City in late spring and early summer, on Long Island in midsummer, and on the Bermudas from March to May (Bull. Nutt. Orn. Club, Vol. V, pp. 7–11). Mr. E. W. Nelson in his paper on "Birds of northeastern Illinois," read before the Essex Insti-

tute, December 4, 1876, says it was "formerly a common winter resident, now rare." Messrs. Dury and Freeman (Journ. Cin. Soc. Nat. Hist., 1879, p. 4) note its occurrence at Westwood, Ohio, in 1879. Dr. J. M. Wheaton (Bull. Nutt. Orn. Club, 1879, p. 62) gives the following account of the occurrence of the species in Ohio:—"On the 18th of June last, Mr. Charles Hinman killed one of these birds out of a flock of eight or ten which visited the coniferous trees in his garden in this city (Columbus). The specimen which came into my possession by the kindness of Mr. Oliver Davie was a male, not in full plumage. I have since learned that the Red Crossbill has remained during the season in the vicinity of Cleveland in considerable numbers, and is reported to have nested there." In commenting on this note (Ohio Geol. Survey, Vol. IV, Zoology and Botany, p. 317) Dr. Wheaton says:—"I was unable to learn whether its nest had been actually discovered," and adds "It has been known to nest in Indiana within a few years." I regret very much that I have been unable to get any clue whatever to the authority upon which the statement is made. Professor A. J. Cook in writing of the The Birds of Michigan says of the American Crossbill "Occasional in summer." Dr. H. A. Atkins took nests of this species at Locke, July 13. 1880. It had previously been reported as breeding in Minnesota.

In July and August, 1880, they were noted at Rugby, Tenn. (The Oologist, Vol. V, pp. 78–9; Bull. Nutt. Orn. Club, Vol. VI, pp. 56–7). Dr. C. Hart Merriam notes it as an "abundant resident" in the Adirondack Region. He says it is "rather scarce and irregular in summer, but the commonest bird in winter and early spring. Breeds in February and March while the snow is still four or five feet deep on the level and the temperature below zero (Fahr.), Have taken fully fledged young in April" (Bull. Nutt. Orn. Club, Vol. VI, p. 229).

Mr. C. W. Beckham (Birds of Nelson County, Kentucky; Ky. Geol. Surv., p. 24) says:—"A flock of six or eight of these birds appeared here on Nov. 18, 1882, in some pine trees, the first time I had ever observed them. They remained only a

day or two, and none were seen until the 17th of March, following, when I shot eight out of a flock of about twenty in the same place where they had previously been seen. Several flocks were observed about the same time near Bloomfield and Glenville in this county, and excited considerable comment on account of their queer bills. The weather at the time was quite mild, so that their appearance here was probably due to some other cause."

The winter of 1882–3, they were unusually abundant in many localities between the great lakes and the Ohio River.

Professor B. W. Evermann first observed them at Bloomington, Indiana, Feb. 10, 1893. This was the second record for the state. For some time after they were common in Monroe County. March 15, 1883, Mr. E. R. Quick reported having seen a single specimen near Brookville, Indiana. April 2, my attention was attracted to a peculiar crackling sound which came from among the pine trees in my yard at Brookville. Close investigation revealed the fact that the cause was a lot of Crossbills. They were shelling the seeds out of the pine cones, and the breaking of the cones made the sound which attracted my attention. I observed others were upon the ground feeding upon the seeds in the fallen cones. April 3, I saw six more in my yard. April 4, I saw one in a flock of Pine Finches. April 5, Mr. Quick noted one. Of those observed, but one was in the red plumage. Professor B. W. Evermann saw a few at Delphi, Carroll County, Indiana, the middle of March, 1883. At the same place about twelve were seen Dec. 26, 1884. Mr. J. W. Byrkit informs me that they were very abundant at Michigan City, Indiana, in the winter of 1883–4. Miss H. E. Colfax in her report of the birds noted at the lighthouse at the same place, gives it Jan. 16, 1884. In the winter of 1883–4, Professor Evermann reported them very common in Monroe County, Indiana.

The Ornithologist and Oologist, Vol. VIII, p. 68, contains an account by A. H. Helme of their breeding April 10, 1883, near Miller's Point. L. I. Mr. Robert Ridgway (The Auk, Vol. I, p. 292) notes the probable breeding of the Red Crossbill in central Maryland in May, 1884. Mr. F. C. Brown

reported their breeding in eastern Massachusetts in the summer of 1884 (The Auk, Vol. II, p. 105). In the winter of 1884–5, they were tolerably common in Monroe County, Indiana (Blatchley in Hoosier Naturalist, 1886, p. 170). The late Mr. C. H. Bollman noted them "quite common" in the same county through March, April and early May, 1885. He saw them first March 2 and last observed them May 12. Mr. J. W Byrkit informed me that he saw the first Crossbills for the year, March 24, 1885. He adds "I am not quite positive, but I think the Crossbills breed, here (Michigan City) as they make their appearance about this time and leave for the north about the middle of May." Mr. Charles Dury informed me they were abundant at Michigan City, Indiana, one winter, which he thinks was 1885. He also reported Pine Finches and Redpolls from the same locality the same year. Professor B. W. Evermann reported it from Carroll County, Indiana, March 27, 1885. I am indebted to Mr. E. M. Kindle for the information that Mr. Sam. Hunter reported a pair of American Crossbills as having bred at Bloomington, Indiana, in 1885. Mr. Hunter informed him they nested in a pine tree and that the nest was made exclusively of pine burrs. Mr. R. R. Moffitt informs me that Red Crossbills were taken in Tippecanoe County, Indiana, in 1885. He says they nested there. Professor B. W. Evermann noted them at Camden, Indiana, March 27 and April 13, 1885, also a large flock at Burlington, Indiana, April 23, 1885.

Mr. Wm. Brester reported its occurrence in the mountains of western North Carolina in the summer of 1885 (The Auk, Vol. III, p. 107) and says:—"Seen only on the Black Mountains where it was numerous in small flocks throughout the balsam forests above 5,000 feet." At Highlands I was told that it regularly appeared in winter about the outskirts of the town. Mr. Charles W. Richmond (The Auk, Vol. V, p. 22) gives upon the authority of Mr. Hugh M. Smith, the information that an adult male American Crossbill, accompanied by a young bird, was seen May 17, 1885, within the District of Columbia.

Professor L. L. Dyche reports the occurrence, in the winter of 1885–6, of the western Red Crossbill, *Loxia curvirostra stricklandi*, at Lawrence, Emporia, Manhattan and Wakarusa, Kansas. They were first observed Nov. 1, 1885, and were last seen Jan. 26, 1886 (The Auk, Vol. III, pp. 258–261). The following winter I was fortunate in securing through the kindness of Mr. A. O. Garrett, a series of specimens of *Loxia curvirostra minor* from Lawrence, Kansas. March 13 and 14, 1887, he obtained four which he sent me, and later he sent me nine others which were taken March 24 and 25. The meeting of the range of these two forms is of considerable interest.

Professor B. W. Evermann reports a Crossbill species not determined from Bloomington, Indiana, Feb. 23, 1886, and another March 8, 1886. The same authority states the late Mr. C. H. Bollman found a few specimens of the Red Crossbill near Bloomington, Indiana, July 10, 13 and 14, 1886. It was found in the White Mountains, N. H. (The Auk, Vol. IV, p. 105). Mr. George B. Sennett, in the same volume, p. 242, gives an account of finding this species in the mountains on the borders of North Carolina and Tennessee in July and August, 1886. Mr. Arthur T. Wayne, in the same volume pp. 287–289, notes their abundance near Yemassee, S. C., in Nov. and Dec., 1886 and in Jan. and Feb., 1887. He noted them again in the same vicinity Nov. 20, 1887 (The Auk, Vol. V, p. 115), also during Jan., 1888 (Ibid, p. 208). Mr. Frank M. Chapman also reports them from Aiken, S. C., Nov. 12, 1887, (Ibid, p. 324). Mr. G. G. Williamson observed them in Monroe County, Indiana, Jan. 18 and Feb. 6, 1886. Mr. J. G. Parker reports them from Lake County, Indiana, in May, 1887. In fall of 1887, I again observed them at Brookville, Indiana. They came to feed upon the pines in my yard. Oct. 29, several were seen and they last appeared Nov. 19. Professor Walter Faxon and Dr. J. A. Allen give it as common in the White Mountains, N. H., in July, 1874, June, 1885 and June, 1886 (The Auk, Vol. V, p. 152). Dr. J. A. Allen on the next page of the same number of "The Auk" speaks of a pair of American Crossbills taken at Mandeville, La., March 27, 1888. Professor B. W. Evermann found them in Vigo County,

Indiana, in the spring of 1888. They were first seen Feb. 6 and disappeared May 6. Mr. J. O. Snyder found them at Waterloo, Indiana, March 13 and 17, 1888. Mr. H. N. McCoy informed me they were quite common in Wayne County, Indiana, in the early part of 1888. They were last seen April 5. Mr. G. G. Williamson saw six or eight individuals near Muncie, Indiana, April 17, 1888; May 4, he saw three others.

Mr. Otho C. Poling notes their occurrence in Adams County, Ills. He gives no account of their occurrence in summer (The Auk, Vol. VII, p. 239). Mr. John A. Balmer informs me these Crossbills were found in the vicinity of Vincennes, Indiana, in the winter of 1888–9. Mr. J. F. Clearwaters told me of the capture of two of these birds in Putnam County, Indiana, in the winter of 1888. A flock of American Crossbills was seen by Mr. J. O. Snyder at Waterloo, Indiana, April 27, 1889. Mr. Stewart E. White informs me he found them common on Mackinack Island, Michigan, Aug. 3 to Aug. 9, 1889. Mr. H. W. McBride wrote me of taking three specimens at Waterloo, Indiana, April 2, 1890. Feb. 14, 1891. Mr. Stewart E. White saw six at Grand Rapids, Mich. He next noted the species March 16. He says it is quite rare in that vicinity. Mr. J. F. Clearwaters gave me the following account of their occurrence in Putnam County, Indiana. "On July 27, 1891, Jesse Earll was down beside the old mill pond, where we collect all our water birds, and noticed five birds on the ground apparently probing in the mud with their bills. As they rose he shot one which proved to be a male Red Crossbill in breeding plumage. He preserved the skin and still has it. The others were females or young, as he says none of them had any red on them."

Mr. Jonathan Dwight reported the American Crossbill on North Mountain, Penn., in June, 1891 (The Auk, Vol. IX, p. 137). Dr. B. H. Warren in his admirable report on the Birds of Pennsylvania, p. 228, gives it as breeding in the counties of Clinton, Clearfield, Luzerne, Lycoming and Cameron, in that state.

March 1, 1892, Messrs. A. B. Ulrey and E. M. Kindle report seeing six in Monroe County, Indiana. Mr. G. G. Williamson

noted six near Muncie, Indiana, April 16, 1892, and another April 24. Messrs. Charles D. and Lewis A. Test have kindly sent me the following interesting notes from the observations of the spring of 1892. The notes were taken near Lafayette, Indiana, March 8, 1892, they saw the first American Crossbill. They were seen on the following succeeding dates: March 11; April 15, 19, 23 and 30; May 1, 3, 6, 8, 18, 20, 21, 27 and 30; June 2, 6, 22, 23, 27 and 30. The birds were seen in pine trees and also in yards and along the road. Search was made for nests but none were found. I am indebted to Mr. Otto Widmann for some valuable notes relating to the American Crossbill in Missouri last winter and spring and summer (1891–2). He says:—"I never suspected these cone-loving nomads to descend into a country so flat and uninteresting as St. Louis County, Mo., where Nature never rears a cone without the help of the gardener. Thousands of young evergreens, especially Norway Spruces, have been planted during the past decade, but old cone-bearing conifers are few and far between. There are on my place, besides a few Norway Spruces, 18 pine trees about 30 years old. Half of them are Austrian Pines, the rest White and Scotch Pines.

Coniferous trees do not bear fruit every year, but last winter the Austrian pines were full of cones, getting ready to drop the seeds in early spring. Besides the maturing pine seeds, our section had another attraction for erratic fruit-eaters in the orchards. The apple trees had yielded an enormous crop and the demand not being sufficiently great to gather them in time, thousands of apples were still hanging in the trees when the Crossbills appeared on the scene. It was in the orchard that they made their appearance on Nov. 13, the day after the first "blizzard" had visited the upper Missouri Valley. From this day on, the Crossbills remained in the neigborhood until the end of the month, but none were here in December and January, at least I did not notice any until they began to visit my pine trees in February. They were daily visitors all through March and until the 17th of April. From that day until May 8th none were seen, but from the 8th to the 14th they were again daily callers. After this date they were

noticed twice; a party of six on June 5th, and two birds, a male and female, in one of my pine trees on July 21st. I looked for the nest in the tree, but unfortunately it was not there. I think now that I have met with the species on several occasions in former years but did not know them. Frequenters of private gardens, they were only seen when on wing or distant tree tops and evaded identification. With us it is a shy and restless bird, easily alarmed and flying a great distance. Before taking wing and while in the air they are quite noisy with a note closely resembling the parent call of *Progne;* but when feeding in a pine tree the whole troop keeps perfectly silent and nothing is heard but the noise made by breaking the cone scales. When present in May they are also feeding on elms."

Mr. W. S. Blatchley gives me the following notes:—"While sitting on the porch of a farm house in Putnam County, Indiaua, July 11, 1892, I saw a single Crossbill *Loxia curvirostra minor* alight in the top of a pine tree in the yard and begin searching the cones for seeds. I watched it for almost ten minutes and then, that there might be no possibility of mistake in the identification, procured a gun and shot it. It proved to be a young male. On July 15th, another young male, i. e., a male presumably of the previous year's hatching, was secured from the same tree and kept in confinement for several days, but was finally allowed its liberty."

The American Crossbills have, as has been shown, been noted within the region between the great lakes and the Ohio River in the following winters: 1868–9; 1869–70; 1874–5; 1882–3; 1883–4; 1884–5; 1885–6; 1887–8; 1888–9; 1889–90; 1890–91; 1891–2. From 1882 to 1892 they were only absent one year, 1886–7. In the winters of 1882–3; 1884–5; 1887–8, the area of dispersal was wide and the birds seem to have been generally distributed. Other years as 1868–9; 1869–70; 1883–4 they appeared, or at least were observed, in but few localities, but where noted they were abundant.

The results of the inquiries concerning its summer range, particularly with relation to the Ohio Valley and the territory adjacent thereto have been wholly unexpected. Summing

up the occurrences in summer and the evidence of its breeding in the region last referred to we note as follows. In the summer of 1869 they were abundant in the vicinity of Chicago, both in Illinois and Indiana. In the summer of 1878 they were found at Columbus, Ohio, and abundantly at Cleveland where it was reported to have bred. Dr. Wheaton refers to their having nested in Indiana as a fact well known to him. Dr. H. A. Atkins is said to have taken nests of this species near Locke, Michigan, in 1880. The spring of 1885 they were common at Michigan City, Indiana, and Mr. Brykit thought they might have nested. In the summer of 1885 they were reported to have nested in Tippecanoe County, Indiana. The same summer they are reported to have nested at Bloomington, Indiana. They were reported from Monroe County, Indiana, three different dates in July, 1886. They were reported from Putnam County, Indiana, in the summer of 1891–92. They remained throughout a part of the summer of 1892 at Lafayette, Indiana. They remained even later at Old Orchard, Mo., in 1892.

These notes but serve to bring more clearly to mind the peculiar, erratic character of the bird of which we have known, to some degree, before. The notes would also seem to indicate that much of our lack of data is due to the scarcity of observers in years past. A few years ago the collection of data regarding almost any species of bird from Indiana, or almost any other state, would have been impossible. It is not improbable, could we begin with the abundance of Crossbills at Cincinnati in 1868–9, with a number of intelligent observers equal to that available now, we could have a collection of observations covering its whole range between the Ohio River and the lakes and perhaps including its movements for almost every year. These blank years do not necessarily signify that it was wanting in the territory studied, but that for some one of a great many reasons, it was not observed. The erratic distribution of the species applies as well to its summer range as to that in winter. It seems very probable that the species breeds to some extent throughout the Ohio Valley. It is true that no specimens representing either the nest or eggs have

been, so far as I know, preserved. Yet the evidence presented indicates that the breeding range of the species in the United States is not confined to the coniferous forests of the mountain ranges.

Loxia leucoptera, WHITE-WINGED CROSSBILL.

This species is not met with in the Ohio Valley so often as the last mentioned form. Its range lies farther to the northward. Its distribution within the United States, both in winter and summer is much less extensive than is that of the American Crossbill. Audubon mentions its breeding in Pennsylvania in summer, but this is probably an exceptional case. Dr. J. M. Wheaton gave it in his catalogue of Birds of Ohio in 1861. Mr. Charles Dury found them abundant in the vicinity of Cincinnati, Ohio, in the winter of 1868–9, in company with the last mentioned species. He says "they were in large flocks containing both species in the proportion of two of the former to one of the latter" (the present), "species." Mr. C. E. Aiken informs me that this species was in company with the American Crossbill when they were so common in the vicinity of Chicago in the summer of 1869. He also noted them in Lake County, Indiana, the latter part of August of that year. He says they displayed the same habits as the preceeding species. His recollection is that the white-winged forms was less abundant, a little later in their arrival, and more wary. They remained through the winter. Professor A. J. Cook informs me that one was killed by Dr. A. H. Atkins at Locke, Michigan, Aug. 9, 1875. A pair of white-winged Crossbills were taken at Fort Wayne, Indiana, about 1878. The female is now in the collection of Mr. C. A. Stockbridge of that city.

Mr. W. L. Scott notes the occurrence of a flock of white-winged Crossbills near Ottawa, Canada, toward the latter part of June 1882 (The Auk, Vol. I, p. 159). Mr. Fletcher M. Noe notes the occurrence of this species near Indianapolis, Indiana, in the early part of 1883. Feb. 6, 1883. Professor B. W. Evermann shot two males from a flock of fifteen of these birds in a yard at Bloomington, Indiana. Feb. 10, he secured a

female and, a few days later, two other specimens near the same place. Miss H. E. Colfax reports it from Michigan City, Indiana. June 26, 1884, Mr. J. W. Byrkit found both species together in large flocks near Michigan City, Indiana, the winter of 1883–4. Mr. Charles Dury reports it from Michigan City, Indiana, he thinks in 1885. Faxon and Allen report seeing a few in the White Mountains, N. H., June, 1886. (The Auk, Vol. V, p. 152). Hon. R. Wes McBride has noted it as a winter visitor in De Kalb County, Indiana. Dr. C. Hart Merriam gives it as a resident in the Adirondack region but adds, comparing it with the American Crossbill, "not nearly so common as the last." (Bull. Nutt. Orn. Club, Vol. VI, p. 229). Professor B. W. Evermann informs me that he saw one in the spring of 1886 in his brother's yard at Burlington, Indiana. He says "after watching it for awhile I struck it with a stick, killing it." March 16, he saw another specimen of this species at Camden, Indiana.

The only instance I know of its occurring in the Ohio Valley in summer, is that given by the late Mr. C. H. Bollman. He wrote me that he saw eleven on a fir tree in Bloomington, Indiana, June 24, 1886. A few days later he several times noted specimens of the other species.

Everywhere in the Ohio Valley this species seems to be quite rare and exceedingly irregular in its occurrence. Mr. E. W. Nelson and Mr. Otho Poling note it as much less common in Illinois than formerly. With the exception of the winter of 1868–9 and the succeeding summer, I do not know of its having appeared in any considerable numbers in any of the tier of states just north of the Ohio River.

RECENT BOOKS AND PAMPHLETS.

Administrative Report of the Government Central Museum of Madras for the year 1892–93.

BARUS, C.—The Compressibility of Liquids. Bull. U. S. Geol. Surv. No. 92. Washington, 1892.

——The Mechanism of Solid Viscosity. Bull. U. S. Geol. Surv. No. 94. Washington, 1892. From the U. S. Geol. Surv.

——The volume Thermodynamics of liquids. Bull. U. S. Geol. Surv. No. 96. Washington, 1892. From the U. S. Geol. Surv.

BOULE, M.—L'homme paléolithique dans l'Amerique du Nord.——Une excursion géologique daus les montagnes rocheuses. Extr.

BRIGHAM, A. P.—The Finger Lakes of New York. Extr. Bull. Amer. Geog. Soc., Vol. XXV, 1893. From the author.

Bulletin No. 3, 1893, Agricultural Exp. Station College of Agriculture, University of Idaho. Application of Chemistry to the Agricultural Development of Idaho.

Bulletin 23, 1893, Agri. Exp. Station of the Rhode Island College of Agriculture and Mechanic Arts. Fertilizers.

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CARTER, O. C. S.—Artesian Wells. Extr. Proceeds. Franklin Inst., Sept., 1893.

——Artesian Well in Lowest Trias at Norristown. Extr. Proceeds. Am. Philos. Soc., Vol. XXIX, 1891. From the author.

——Catalog of A. S. A. Library, shown at the World's Columbian Exposition. Washington, 1893. From the Bureau of Education.

CLARK, F. W.—Report of work done in the division of Chemistry and Physics, mainly during the fiscal year 1890–91. Bull. No. 90, U. S. Geol. Surv. Washington, 1892. From the U. S. Geol. Surv.

CLARK, W. B.—Correlation Papers—Eocene. Bull. U. S. Geol. Surv. No. 83. Washington, 1891. From the U. S. Geol. Surv.

Contributions from the Zoological Laboratory of the University of Pennsylvania, Vol. I, No. 1, 1893, From the University.

COOK, A. J.—Birds of Michigan. Bull. 94, 1393, Agri. Exp. Station, Mich. State Agri. College. From the author.

CRAGIN, F. W.—A Contribution to the Intevrebrate Paleontology of the Texas Cretaceous. Extr. Fourth Annual Rept. Geol. Surv. Texas, 1892. From the Survey.

DALL, W. H. AND HARRIS, G. D.—Correlation Papers. Neocene, Bull. U. S. Geol. Surv. No. 84. Washington, 1892. From the U. S. Geol. Surv.

DALL, W. H.—A Subtropical Miocene Fauna in Arctic Siberia. Extr. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the Smithsonian Institution.

DARTON, N. H.—Record of North American Geology for 1890. Bull. U. S. Geol. Surv. No. 91. Washington, 1891. From the U. S. Geol. Surv.

EIGENMANN, C. H.—On the Occurrence of the Spiny Box Fish (Genus Chilomyc-

terus) on the coast of California. Extr. Proceeds. U. S. Natl. Mus., Vol. XV, 1892. From the Smithsonian Institution.

FISHER, W. H.—Investigations of the Burrows of the American Marmot (*Arctomys monax*). Extr. Journ. Cin. Soc. Nat. Hist., 1893. From the author.

FONTAINE, W. M.—Description of some Fossil Plants from the Great Falls Coal Field of Montana. Extr. Proceeds. U. S. Natl. Mus., Vol. XV, 1892. From the Smithsonian Institution.

HAY, W. P.—Observations on the Blind Cray Fishes of Indiana with a description of a new subspecies, *Cambarus pellucidus testii*. Extr. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the Smithsonian Institution.

HOLDEN, E. S.—Earthquakes in California in 1890 and 1891. Bull. U. S. Geol. Surv. No. 95. Washington, 1892. From the U. S. Geol. Surv.

HOLLICK, A.—Plant Distribution as a Factor in the Interpretation of Geological, Phenomena, with special reference to Long Island and vicinity.——Preliminary Contribution to our Knowledge of the Cretaceous Formation on Long Island and Eastward. Extr. Trans. New York Acad. Sciences, Vol. XII, 1893. From the author.

JORDAN, D. S.—A Description of the Golden Trout of Kern River, California, *Salmo mykiss agua-bonita*. Extr. Proceeds. U. S. Natl. Mus., Vol. XV, 1892. From the author.

KENNEDY, W.—Report on Grimes, Brazos, and Robertson Counties, Extr. Fourth Ann. Rept. Tex. Geol. Surv. for 1892. From the Survey.

KNOWLTON, E. H.—Notes on a few Fossils Plants from the Ft. Union Group of Montana, with a description of one new species. Extr. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the Smithsonian Institution.

MCMURRICH, J. P.—Report on the Actiniæ collected by the U. S. Fish Com. Steamer Albatross during the winter of 1887–1888. Extr. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the Smithsonian Institution.

MORGAN, T. H.—Experimental Studies on Teleost Eggs. Extr. Anat. Anz. Jena 1893. From the author.

PAVLOW, M.—Note sur un Nouveau Crâne d'Amynodon. Extr. Bull. de Moscou, 1893. From the author.

RIDGWAY, R.—Description of a supposed new species of Odontophorus from southern Mexico. Extr. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the author.

ROSE, DR. C.—Ueber das Jacobson Organ von Wombat und Opossum.——Ueber die Nasendrüse und die Gaumendrüsen von *Crocodilus porosus*. Abdruck aus Anat. Anz., Jena, 1893. From the author.

SALISBURY, R. D.—Surface Geology of New Jersey. Report of Progress. Extr. Ann. Rept. State Geol. for 1892. From the author.

SCUDDER, S. H.—Some Insects of special interest from Florissant, Colorado and other points in the Tertiaries of Colorado and Utah. Bull. of the U. S. Geol. Surv. No. 93. Washington, 1892. From the U. S. Geol. Surv.

SHUFELDT, W.—On the Mechanism of the upper Mandible in the Scolopacidæ. Extr. Ibis, Oct., 1893. From the author.

STEARNS, R. E. C.—Preliminary Report on the Molluscan species collected by the U. S. Scientific Expedition to West Africa in 1889–90.——On rare or little known Mollusks from the west coast of North and South America, with descriptions of new

species.——Report on the Mollusk Fauna of the Galapagos Islands, with descriptions of new species.——Report on the Pteropods and Heteropods collected by the U. S. Steamer Albatross during the voyage from Norfolk, Va., to San Francisco, Cal., 1887–'88. Extrs. Proceeds. U. S. Natl. Mus., Vol. XVI, 1893. From the Smithsonian Institution.

TAFF, J. A.—Report on the Cretaceaus area north of the Colorado River. Extr. Fourth Annual Rept. Tex. Geol. Surv. for 1892. From the Survey.

WELCH, G. T.—Therapeutical Superstition. Extr. Trans. N. J. Med. Soc., 1893. From the author.

WHITE, C. A.—Correlation Papers.—Cretaceous. Bull. U. S. Geol. Surv. No. 82. Washington, 1891. From the U. S. Geol. Survey.

WHITFIELD, R. P.—Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey. Trenton, 1892. From the New Jersey Geol. Survey.

——Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey. Monograph of the U. S. Geol. Surv., Vol. XVIII. Washington, 1892. From the U. S. Geol. Survey.

WOLTERSTORFF, W.—Die Reptilien und Amphiben der Nordwestdeutschen Berglande. Magdeburg, 1893. From Herr Wolterstorff.

RECENT LITERATURE.

Zirkel's New Text Book of Petrography.[1]—Although entitled a 'Lehrbuch' the revision of Prof. Zirkel's well known Petrography has rather the character of a 'Handbuch.' The first of the three volumes proposed to complete the work contains an introduction to the study of rocks, a description of the methods made use of in this study, an account of the peculiarities of form presented by rock-forming minerals, a review of the characteristics of each of the most important of these, a discussion of rock structure and the causes of its variation, a statement of the method of occurrence of rock masses, a chapter in the physical properties of rocks and one on the changes which they undergo when subjected to external influences. Following these, which occupy in all 635 closely printed pages, there are some 190 pages in the mineral, chemical and structural relations of massive rocks, and a very full discussion of the theories proposed to explain the origin of the variations observed in rock masses, and in the different emanations from the same volcanic centre, which concludes with the scheme of classification for massive rocks that the author intends to follow in the succeeding volume.

As the synopsis of the contents shows Prof. Zirkel expects to cover the entire field of petrography in a way that has never been attempted hitherto. He will treat not only of the massive rocks, but of the sediments and crystalline schists as well. The first volume gives no evidence as to the fullness with which the individual rock types will be discussed, but it is quite certain that the three volumes will fill a place that has long been ready for them in the working room of every petrographer.

The special excellencies of the volume before us consist in the very complete bibliographies appended to or inserted within the paragraphs pertaining to different heads, the thoroughness with which the field has been covered by it, and the freshness of the material between its covers. Of course the second edition is not a revision of the author's first edition of the Lehrbuch. It is an entirely new book, rewritten from 'preface to finis.' And more than this—it contains references to the very latest petrographical researches published in this country as

[1]Lehrbuch der Petrographie by Dr. Ferdinand Zirkel. 2te Aufl., Erster Band. Leipzig, Wilhelm Engelmann, 1893. Pp. x and 845.

well as in Europe. The faults of the book are such only when it is criticized as a Lehrbuch. As a manual it is very satisfactory, though one would wish that the author had made his list of rock-forming minerals more complete than it is, and had given more detailed instructions as to the manipulations in some of the investigation methods mentioned. Upon comparison with Rosenbuesh's first volume it is found that this treats of forty-four more minerals than does Zirkel's book, but then the Heidelberg volume deals only with microscopical petrography. Further, the absence of illustrations from the Lehrbuch will prevent its use as a text book for students, and the failure to attempt an explanation of the action of mineral plates toward polarized light will in large measure keep it from even our universities and technical schools. But these faults, we repeat, are faults in a text book. They are not altogether weaknesses in a hand-book. Zirkel will become the reference book of petrographers, while Rosenbuesh will remain their text book.

In that portion of the volume occupied with the special discussion of massive rocks, the author outlines his classification and gives his reasons for it. He declines to recognize the dyke rocks as a well established class, and so makes his division (according to structure and mineralogical composition) into granular and porphyritic groups, and then into types. In the first group, age distributions are disregarded. In the second group the old distinction between pre-tertiary and tertiary volcanics is revived. Petrography is regarded as primarily as a study of rock bodies, and secondarily as a branch of geology.

The lack of illustrations which has already been noted will not detract seriously from the value of the volume as a reference book, as the author has no new structures to define and no new rock-types to establish. He gives an excellent resumé of petrographical literature and there stops. He has no theories to advance and no attacks to his brother investigators, except now and then, a mild one upon Rosenbusch, and his discussions upon the literature are uncolored by his own views. Now and then a criticism is interjected into the discussion, but upon the whole the author allows the conclusions reached in the articles cited to stand unchallenged, or if they are challenged it is by the citation of other authors. In brief the Lehrbuch is an excellent résumé of our present knowledge of rocks and a fine reference book to petrographical literature. Naturally more interest will be felt in the two volumes to appear, than in the first volume, for at least one of these will afford a starting point for a systematic petrographical study of the crystalline schists. W. S. B.

Zimmermann's Botanical Microtechnique.[2]—In bringing out so promptly an English translation of this useful work, the German edition of which reached American workers a little more than a year ago, both translator and publisher have rendered a good service to the laboratory botany of the country. The original was so well received, and had proved itself to be so useful in the laboratory, that this neatly printed and bound volume must at once find wide and general use. The beginner will find here a work which he may follow implicitly without fearing that he will laboriously learn some method, only to find a little later that it is an antiquated or discarded one.

In order to give those who have not seen the original an idea of the scope of the work we reproduce the contents of Part I.

General Methods.

1. The Observation of Living Plants and Tissues.
2. The Investigation of Dead Plants.
3. Maceration.
4. Swelling.
5. Clearing.
   - A. Chemical Clearing Methods.
   - B. Physical Clearing Methods.
     - I. The Ordinary Method of Transfer from Water to Canada Balsam.
     - II. The Transfer from Water to Canada Balsam without Alcohol.
     - III. The use of other Strongly Refractive Mounting Media.
6. Live Staining.
7. Fixing and Staining Methods.
   - A. Fixing. B. Removal of Fixing Fluids. C. Staining.
   - D. Fixing and Staining Microscopically small Objects.
8. Microtome Technique.
   - I. Imbedding in Paraffine. II. Imbedding in Celloidin. III. The Attachments of Sections.
9. Making Permanent Preparations.

From the foregoing it will be seen that every point under the head of general laboratory methods is taken up, and an examination of the paragraphs shows the thoroughness of the work. The illustrations of which there are many, add much to the usefulness of the work.

[2]Botanica Microtechnique. A handbook of methods, for the preparation, staining and microscopical investigation of vegetable structures by Dr. A. Zimmermann, Privat-Docent in the University of Tübingen. Translated from the German by James Ellis Humphrey, S. D. New York, Henry Holt and Company, 1893, pp XII, 296.

Dr. Humphrey has added here and there many valuable notes, and at the end has added six pages of useful "Tables for Reference." The literature of the subject is given with such completeness thas it requires nineteen pages. A full index with from 1200 to 1500 references completes this most satisfactory book.

CHARLES E. BESSEY.

The Letters of Asa Gray.[3]—It is rarely the case that a life is more justly and clearly set forth in a biological writing than is the life of the eminent botanist Asa Gray, in those two volumes prepared by Mrs. Gray. With rare good taste and admirable tact she has woven from the brief autobiography and the letters scattered through fifty-six years the charming story of his life. We can all wish for a such hand to set forth our life-work, when we have passed away.

The quaintly written autobiography tells of his early life, and of his struggles to reach some position in which he might do the work Nature had fitted him to do. There were many disappointments; many plans were made only to be overthrown or abandoned. At last came the appointment to the chair of Natural History in the newly chartered University of Michigan, and the year's leave of absence and commission to purchase books for its library. How well he used that year in Europe is told in the enthusiastic letters he wrote home to Dr. and Mrs. Torrey and "the girls." Thenceforward his life-work was assurred, and upon his return he took up with vigor the work on the Flora of North America with Dr. Torrey, a work which he left unfinished after forty-eight years of continuous work.

It is impossible to give an adequate idea of these books in a brief notice. These extracts from letters more than fifty years apart may be suggestive. To his mother he wrote from New York in February, 1835, "I wish very much to spend a few weeks Georgia early in the spring, but I see that I shall not be able to do so. My time is spent here very profitably, and I am advancing in knowledge as fast as I ought to wish, but I make no money, or scarcely enough to live upon. Just at present I am rather behind hand, but think that by next fall I shall with ordinary success be in better circumstances. It is unpleasant to be embarrassed in such matters, for I should like much to be independent, and this with my moderate wishes would require no very large sum, and I have no great desire to be rich."

[3] *Letters of Asa Gray.* Edited by Jane Loring Gray, in two volumes.. Boston and New York, Houghton, Mifflin and Company. The Riverside Press, Cambridge, 1893, 12 mo., 838 pp.

Contrast the foregoing with the following written from Kew, April, 1887, to De Candolle.

"You will be a little surprised at the sudden transfer of Mrs. Gray and myself to England, but I wanted a vacation and one more bit of pleasant travel with Mrs. Gray while we are both alive and capable of enjoying it. Whether I shall look in upon you at Geneva is doubtful, but it may be even for a moment. We never expect to have repeated the pleasant work at Geneva of the spring of 1881. We expect to go to Paris in May, but subsequent movements are uncertain. Always dear De Candolle, affectionately yours."

These volumes will always be interesting to American botanists, especially to those who enjoyed Dr. Gray's personal acquaintance.

CHARLES E. BESSEY.

A Theory of Development and Heredity.[4]—This volume recently issued by the Macmillans with the above title will no doubt find a good many readers. It is a book that deserves perusal, in that it presents with clearness the main issues that are how agitating biologists, though the bias of the author is decidedly Lamarckian. In fact, it is probably the strongest popular contribution to the Lamarckian side of the controversy that has yet appeared. The author states that in the first place the work is an effort to extend the application of the law of the conservation of energy to the phenomena of living matter, and to resolve the premises given by the science of physics to their conclusion in the realm of biology. How far he has succeeded may be open to question, but his array of facts in support of his views is certainly very creditable. Many of these facts have been known for a good while to biologists, but the author of the volume has brought them into their proper collocation in respect to each other and has made out a very strong argument in support of his position. In the second place, to use his own words, "it is the extension to all living matter of certain fundamental properties of life which psychology has either proved or tacitly assumed to exist in the higher animals." He here refers to the effects of repetition and association operating through a coördinating nervous mechanism or system. His view of organic evolution, is that it is a mechanico-psychological process. In this respect his views are closely similar to those of Cope published long since in a collected form—Cope's view is that consciousness is to be regarded as an important factor in evolution, just how it operates is

[4]A Theory of Development and Heredity, by Henry B. Orr, Ph. D. Macmillan & Co., London & New York, 1893, crown 80, pp. ix and 255.

not so definitely stated as by Orr, who finds in the nervous system the coördinating mechanism through which consciousness manifests itself, but under the domination of the laws of the conservation of energy.

The author does not claim to have made any new discovery, but only to have brought known facts into new relations. There is however, a lamentable defect palpable throughout the book in respect to the citation of authorities. In some cases, in which our author is not alone, he entirely forgets to cite those who have published similar views long before the appearance of his work. The suggestion that all biological phenomena must be interpreted in terms of the theory of the conservation of energy was a thesis defended in several papers published by the present reviewer during the last five years. In his argument in support of the first view that energy must be considered first of all, the author also fails to appreciate the great complexity of the mechanism represented by the cell, nor does he seem to have made himself familiar with the very important and pregnant results of Quincke, Bütschli, Berthold, Dreyer and others. In another place a discovery is mentioned that is undoubtedly to be the first of all accredited to Prof. Alpheus Hyatt, instead of to Wurtenberg, namely, that evolutionary changes in the Ammonites first show themselves on the outer or last whorl of the shells of these organisms. No credit is allowed Prof. Eimer on p. 63, where in a few sentences some of the most important results of that ingenious writer are epitomized in regard to growth itself as a factor in organic evolution. In the chapter on the origin of variations, there is some very crude speculation, that will hardly bear critical examination, and in one place the author shows that he is altogether unfamiliar with Fick's very important and interesting experiments bearing on the origin of joints and the forms of articular surfaces. *Actinosphærium* is misspelled "*Actinosphæro*," and a *cellular* structure is ascribed to this protozoan, and the author also falls into a teleological trap when he asserts that the vesicles and their walls "cellular spaces" in this organism are for the purpose of giving it permanence of figure and support. On page 49, it is stated that "pigment is caused by light acting upon the tissues and where there is no light there can be no pigment." To this it might be replied, how about the black pigment of the *substantia nigra* of the human brain; that is certainly shut out from the light in the centre of the head? With certain reservations it is however, certainly true that pigmentation is associated with the influence of light as the experiments of Cunningham and Schiedt on widely diverse forms have proved. The direct and interesting correlation between coloration and

latitude, first noticed by the late Prof. Baird to hold of closely allied species or of individuals of the same species from different latitudes is not mentioned by the author. The principle of acceleration and retardation, first strongly put forward as early as 1869 by Prof. Cope is also not mentioned, though partly involved in Weismann's quoted statement of the laws governing the ontogenetic appearance of characters given on p. 141.

This failure to render credit where a citation by title would have answered the purpose, is all the more evident by reason of the way in which American naturalists generally have been ignored, as is shown by the details given above, but to which much might be added. The introductory chapters are very suggestive, however, and bring in certain physical evidence in a new way. Especially suggestive is the theory of after-effects here foreshadowed, and which is especially well supported by facts cited from Detmer in Chapter IV. The fallacious arguments of the ultra-selectionists in regard to the origin of blind cave forms, are ingeniously answered in Chapter XII. The results of Stahl and Frank in changing the structure of plants by charging their environmental relations are epitomized, as well as Born's and Yung's experiments in determining the sex and growth of tadpoles by means of the food are briefly detailed and used as evidence. No reference is made to the experiments of Mrs. Treat or of Mr. Gentry in this connection.

To sum up the book is well worth careful perusal, and is to be commended to students of the present activity amongst naturalists in regard to the problems of heredity. Dr. Orr's book, on the whole, presents the Lamarckian side of the argument with unusual fairness and completeness. The book would be greatly improved by the addition of a full index which it is to be hoped may be supplied in a future edition. This book is also an indication of the tendencies of the times, namely, of an effort to trace all phenomena including those of life to their physical sources. That such end will some day be achieved there can scarcely be any doubt, since experimental endeavor is now busy with the work of imitating the phenomena of life by artificial and experimental means, such for example, as the production of artificial amœbæ.—R.

The Wilder Quarter-Century Book.[5]—This volume is a col-

[5]The Wilder Quarter-Century Book. A Collection of Original Papers dedicated to Prof. Burt G. Wilder at the close of his twenty-fifth year of service in Cornell University (1868–1893). By some of his former students, Ithaca, N. Y., 1893.

lection of scientific memoirs published by some of Prof. Burt Wilder's former students, to commemorate the twenty-fifth anniversary of his connection with Cornell University. These essays deal with a wide range of subjects, but are mainly in the line of evolutionary thought. Among the contributors are artists, instructors, physicians, officers in government departments, professors in medical colleges and in universities, and a university president. The papers are prefaced by a list of the more important scientific publications of Prof. Wilder, and a brief sketch of his work at Cornell University, including a table of the number of students personally taught by him during each college year from the beginning of the University (1868) to the twenty-fifth commencement, (1893).

The illustrations comprise an excellent portrait (Japan proof), 26 plates, and 36 figures in the text.

The book embraces many papers which contain the results of original scientific research by their authors. The whole constitutes a permanent monument not only to man whom it was assigned thus to honor, but to Cornell University, and to the devotion of the contributors to the true spirit of science.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Geological Structure of the Mount Washington Mass of the Taconic Range.—The recent studies of Mr. Wm. H. Hobbs have disclosed new facts with regard to the Mount Washington Mass and the conclusions that the author draws from the data now known differ somewhat from those reached by Mr. Dana regarding the structure of Mt. Washington.

Mr. Hobbs' paper is prefaced by the following brief account of the topography of the region in question:

"That portion of the Taconic Range which is known as Mount Washington is both topographically and geologically a unit. It covers an elongated elliptical area, about fifteen miles in length and four and one-half miles average breadth, lying in the states of Massachusetts. Connecticut and New York. It occupies the entire township of Mt. Washington and portions of Sheffield and Egremont in Massachusetts; about one-third of Salisbury in Connecticut; and portions of Northeast Ancram, Copake and Hillsdale in New York.

The Mt. Washington mass is a double ridge enclosing a summit plain. Mt. Everett, or the "Dome of the Taconics" (2624 ft.), lying in the eastern ridge, is the highest peak and one of the highest elevations in Massachusetts, while the Bear Mountain (2355 ft.) is the highest point of land in the state of Connecticut. The main summit plain is situated to the northward centre of the mass and has an average altitude of about 1700 feet. Corresponding with the elliptical outline of the mountain, this plain is compressed at the north and south, so that its length is about three miles and its breadth two miles. Encircling it is a line of peaks ranging from 1900 to 2600 feet in height. This encircling wall of peaks is buttressed by other peaks both to the northward and to the southward, the southern side being strengthened, by a parallel belt across the mountain, composed of Mts. Bear, Gridley, Frissell and Monument. Southward of this belt of hills the elevated plateau recurs, but without the rampart of peaks which characterize it in the northern and more central area.

"The Salisbury-Sheffield valley on the east and the Copake-Hillsdale valley on the west of the mass, constitute a floor having an average altitude of 700 feet, from which Mt. Washington rises abruptly,

the mean slope-angle being 20°. The southern boundary of the mountain is the nearly east and west valley through which runs the Central New England and Western Railroad. On the northwest Mt. Washington is merged into the narrow ridge of the Taconics, which extends northward into Vermont. The name, Mt. Washington, however, applies properly to all of the range lying south of the South Egremont-Hillsdale turnpike. The regular elliptical contour of the mass is broken on the northeast by two deep embayments, the eastern one containing Fenton Brook, and the western, which is knee-shaped, being occupied by Sky Farm Brook. The regularity of contour is further interrupted by an outjutting spur on the west side, known as Cook's Hill. South of the topographical break which limits the mountain in the neighborhood of Ore Hill, the range of the Taconics pursues a more interrupted course, the hills becoming smaller and spreading out considerably."

In the account of his investigations the author states that a microscopic examination of thin sections of rocks from Mt. Washington shows clearly that they are strongly metamorphosed clastics. Evidence has been deduced from the secondary growths of feldspars, garnets and tourmalines, as well as from the relations of the different metamorphic minerals to one another, to show that the orographic forces to which these minerals owe their development, operated in several more or less distinct periods.

What is set forth in the paper agrees with Professor Dana's views so far as the northern portion of the area is concerned. It is in regard to the southern and central portions that different views are entertained. Mr. Hobbs attributes this difference, not to errors in Professor Dana's observations, for in the main they have been confirmed, but to the collection of a larger number of observations and to the application of some structural principles which were not made use of by Professor Dana.

In conclusion Mr. Hobbs gives the following summary of the results discussed in the paper:

"The Mt. Washington series consists of four members which, in order of age are as follows: (1) Canaan Dolomite, (2) Riga Schist, (3) Egremont Limestone, and (4) Everett Schist. A somewhat striking lithological distinction is found to separate the two schist horizons, the Everett shist being entirely free from garnet and staurolite, while the Riga shist usually (not always) contains macroscopic crystals of one or both. The older rocks are found in the southern portion of the area, a general northerly pitch carrying them successively below the

surface as we proceed northward, until at the north end of the mountain we find the upper two members of the series only.

"The structure of the mass may be summarized by stating that the beds have been thrown into corrugated folds which seem to have moderate, tolerably symmetrical corrugations at the south end of the mountain, but these corrugations deepen and become frequently overturned as we proceed northward. In the eastern portion of the area the axes of the reversed folds is generally westward. At the extreme south, the structure is a geo-anticlinal, but this develops in the central and northern parts of the area into a geo-synclinal owing to the continual disproportionate deepening and widening of one of its minor western corrugations. The general pitch of the beds is north. A less important southerly pitch which characterizes the northern portion of the area, in combination with the general synclinical structure in cross sections, gives to all the mountain except its extreme southern portion a basin-like character. The rocks are throughout strongly metamorphosed clastics, the orographic disturbances to which they owe their marked crystalline character and porphyritic crystals having operated in several distinct periods. The Egremont Limestone shows a marked diminution in thickness as we proceed southward in the area until it almost disappears. Throughout the mountain plain it is greatly modified, being either a micaceous limestone or calcareous mica schist, or a graphitic schist. The graphitic rock is most developed near the schist contacts and in the southern portion is the only representative of the limestone (Journ. Geol., Vol. I, 1893).

Origin of the Pennsylvania Anthracite.—In a recent Bulletin of the Geological Society of America (Nov. 1893) Mr. J. J. Stevenson discusses the origin of the anthracite coal of Peensylvania. After stating the hypotheses that been advanced by Rogers, Owens, Murchison and Lesley, to account for the variation in the volatile combustibles in Pennsylvania coals, and pointing out objections to each in turn, the author offers one of his own, giving the facts upon which it is based. He conceives the coal-measures marsh to have had its origin to the east, and that it extended seaward after each period of accelerated subsidence, so forming a new coal bed. One should find, according to this hypothesis, a greater mass of coal in the northeastern portion of the Appalachian basin than in any other part, and also a greater degree of conversion. Observation has shown that this is the case. There is also a direct relation between the increasing thickness of coal and the decreasing volatile in Pennsylvania. This fact is demonstrated by Mr.

Stevenson in a table of ratios, the result of analyses made by Mr. A. S. McCreath.

In origin then, according to Mr. Stevenson, the anthracite of Pennsylvania differs in nowise from the bituminous coal of the Appalachian basin, but is the result of a longer exposure to the process of making.

Cretaceous System in Canada.—In a Presidental Address before the Roy. Can. Soc., Mr. Whiteaves gave a resumé of the present knowledge of the Cretaceous system in Canada. For convenience, he divides the system into Upper and Lower with the base of the Dakota group as a boundary line. In Manitoba and the Northwest Territories all the Cretaceous rocks as yet examined are referable to the upper division and are subdivided into 5 formations, viz.: Laramie, Montana, Belly River, Niobrara—Benton and Dakota. Of the Rocky Mountain region, inclusive of the Foot-Hills, the author states "that from the combined evidence afforded by the fossil flora and fauna of the Cretaceous rocks of this region it would appear that the Laramie, the Montana, the Niobrara-Benton and perhaps also the Dakota are there represented. The Kootanie series, and the Devil's Lake deposits are older than the Dakota formation and hence referable to the Lower North American Cretaceous." In British Columbia and the Yukon district, although the Cretaceous rocks have been studied and reported upon since 1871, the subdivisions have not yet been satisfactorily correlated with those of Manitoba.

In conclusion the author gives a tabular statement, showing the important additions that have been made to our knowledge of the Canadian Cretacic system since the confederation of the provinces in 1867. Prior to that time but little had been done; to-day, 108 species of fossil plants and 358 fossil animals have been recorded and described, exclusive of the Laramie, or 179 species of plants and 394 animals, inclusive of the Laramie (Trans. Roy. Soc. Can., Sect. IV, 1893).

Evidences of a Submergence of Western Europe at the close of the Glacial Period.—For a number of years Professor Joseph Prestwich has been investigating a peculiar superficial drift found in the south of England and extending over large continental areas. For this drift he proposes the name, Rubble-drift, to distinguish it from the valley, marine and glacial drift of the same regions. It includes a peculiar débris in Loess, the Breccia on slopes, the "Head" over the Raised Beaches, the Basement gravels of many valleys and the Ossiferous fissures. This drift is characterized by (1)

being composed of material of local origin, (2) a complete absence of that wear which results from maintained river, sea or ice action, (3) organic remains which are those of a land fauna alone, (4) by bone fragments free from all marks of gnawing. In order to account for these conditions as well as for the mode of distribution of the rubble, which appears to be from many independent centres, Mr. Prestwich offers the following theory. The Rubble drift is the result of the submergence and re-elevation of a land surface from beneath deep waters after a temporary submergence.

According to the author, this submergence occurred at the close of the Glacial, or so-called Post-glacial period, and immediately preceding the Neolithic or recent period. The submergence affected western Europe and the Mediteranean coasts decreasing eastward. The Rubble-drift and osseous breccia are but slightly developed in Syria. In regard to the north coast of Africa, Mr. Prestwich doubts if the submergence extended beyond the Lybian desert, as there is no well defined proof of it in Egypt.

The significance of the Rubble-drift has an important bearing upon an estimate of the lapse of time since the close of the Glacial period. Mr. Prestwich calls attention to this in his closing remarks, citing evidence to show that Mr. Croll's reckoning of 80,000 years is not supported by the facts of geology. The position and character of the Rubble-drift shows that the transition from the so-called Post-glacial beds to the recent alluvial deposits is abrupt, and there is no absence of sedimentation or anything indicative of lapse of time between the two series. This conclusion is confirmed by sections of the Belgian caves.

Neither is the Croll theory, in the opinion of the writer, warranted by archeological evidence, for "it is hardly probable," to quote the author, "that Man, who showed himself progressive early in the Quaternary period, could towards its close, have remained for, say 70,000 years, without further progress than that shown by Man of the early Stone period. There is nothing to represent, geologically, that long period of time, nor have biologists been able to detect any essential structural differences between Palæolithic Man and Neolithic Man in support of such a conclusion. All the evidence tends to prove that late Glacial (or post-glacial) Man, together with the great extinct Mammalia, came down approximately to within some 10,000 or 12,000 years of our own times, and that the Rubble-drift marks the stroke of the pendulum when the Glacial period came to a close, and the Neolithic age commenced."

A number of cuts and a map of western Europe showing the chief places submerged illustrate the text (Phil. Trans. Roy. Soc. London, Vol. 184, 1893).

Geological News, General.—According to Mr. Oldham, the three main divisions of India are natural regions. The peninsula consists of land which has not been submerged since the early Paleozoic period. The continental has been frequently under water until the Cenozoic, while the great plain is recent alluvium. There is paleontological evidence of a continuous land connection between India and Africa in the Cretaceous period. At the close of the Cretaceous there was an outbreak of volcanic activity contemporary with a series of earth-movements which led to the first appearance of the extra-peninsular mountains, and the depression at the base of the Himalaya. This activity continued during Cenozoic time. (Nature, Dec., 1893.)

Mr. Robert Hay gives some interesting results of a boring made at Paola, in eastern Kansas, which reaches a depth of 2,500 feet. After passing through the coal measures and subcarboniferous it is difficult to determine the formations, the samples being so finely comminuted. At 2,100 feet granite is reached, at first a gray granite—angular quartz and mica with some feldspar—and then a red feldspar with little mica and no quartz, like the outcrop at Ute Pass, Colorado. (Trans. Kansas Acad. Sci., Vol. xiii).

Archean.—In a study of a group of quartzite exposures in southeastern Wisconsin, Mr. Buell finds evidence of dynamic action accompanying the metamorphism of these rocks which is at variance with the more common structure of the pre-Cambrian quartzites of the region of the Great Lakes and Upper Mississippi, as described by Dr. Van Hise. These differences afford criteria for the separation of the quartzite drift of this area from boulder material from other sources and enables a more exact delineation to be made of the boulder trains that extend upon and within the different glacial formations of the Rock river valley. (Trans. Wisc. Acad., Vol. IX, 1893.)

Mesozoic.—Two new Ammonites from the Cretaceous rocks of Queen Charlotte Island are described by Mr. J. F. Whiteaves. Both specimens are small but clearly referable to the family of Stephanoceratidæ of Neumayer. The first, *Holcostephanus deansii*, belongs to the small group of which *H. astieri* is the type; the second, *Hoplites haidaquensis*, is very similar to *H. sinuosus* of the French Neocomian. (Can Record Sci., Oct., 1893.)

According to Mr. S. W. Williston the thickness of the Niobrara rocks in Kansas have been underestimated. Repeated observations at Elkader, in Logan Co., give 290 feet between the bottom of the valley and the highest Niobrara rocks. Wells in the vicinity penetrate 40 feet without passing through the blue chalk. To this, for stratigraphical reasons, he adds 100 feet, giving as a minimum 430 feet at a total thickness at this place. (Trans. Kansas Acad. Sci., Vol. XIII.)

Cenozoic.—Mr. C. T. Simpson reports eight species and one variety of Unios and six species of other fresh water shells from the drift of Toronto, Canada. All the Unios are characteristic forms of the Mississippi Valley, and only three have ever been reported before from Canada. The fossils were obtained from a bed of sand between two glacial beds in a railway cut, 20 or 25 feet above the River Don. Mr. Dall calls attention to the important bearing which these fossils may have upon the theory of a mild interglacial period, during which these Mississippi species attained that region where they flourished for a time and were then destroyed by an advance of the ice. (Proceeds. U. S. Natl. Mus., Vol. XVI, 1893.)

Reasoning from the data gathered for a study of the age of the extra-moraine in eastern Pennsylvania, Mr. E. H. Williams concludes that the total time of the Ice-Age, from beginning to end was small, and of so recent a date that the streams have not reached, in all cases, their pre-glacial bottoms, and the exposed rocks have not had time to acquire signs of decomposition or even oxidation. He inclines to the belief of but one ice age, and that a short and recent one. (Am. Journ. Sci. Jan., 1894.)

Mr. Alfred Bell notes the unique fauna of a post-Tertiary deposit on the shores of the Selsey peninsula in Sussex. Over 330 species in nearly all classes of organic life have been collected, the series exhibiting a purely southern facies free from any northern or boreal forms. An analysis of the list gives the following result: Non-marine, 8 Mammalia, 10 Mollusca, some fragments of insects and 3 plants. Marine, 2 Pisces, 6 Crustacea, 17 Entomostraca, 4 Cirripedia, 4 Annelida, 3 Echinodermata, 216 Mollusca, 10 Polyzoa, 50 Foraminifera, 4 Actinozoa, Algæ, etc. (Annual Report Yorkshire Phil. Soc. for 1892.)

The Manus of Hyopotamus.–Among the treasures obtained in the White River bad lands of South Dakota by the Princeton expedition of 1893 was a fine skeleton of *Hyopotamus*, which was found by Mr. J. B. Hatcher. This specimen presents a number of very unex-

pected characters, which will be described in a full account of the species, with plates, which is now in preparation. Of these, the most striking is the structure of the fore-foot, *which proves to have five well developed digits*, although the genus is a typical artiodactyl. *Hyopotamus* is thus the third artiodactyl genus in which the manus has been shown to possess five digits, the others being *Oreodon* from the White River and *Protoreodon* from the Uinta Eocene. Kowalowsky's material belonged to many different individuals, and when put together, did not suggest the presence of the pollex. In the specimen before us the first metacarpal is proportionately much longer and heavier than in *Oreodon*; its length is 41 mm. while that of the third metacarpal is 94 mm. It is quite stout, especially anteroposteriorly, and laterally compressed, with well formed distal trochlea, which demonstrates the presence of phalanges. The trapezium is large, but strange to say, has but slight connection with the scaphoid. The proximal surface of the magnum is occupied principally by the scaphoid, though to a less degree than in the oreodonts. The other metacarpals (II–V) are heavier than those which Kowalwsky has figured.

This specimen renders it altogether probable that the earliest artiodactyls were all five-toed and that the larger number of the Eocene members of the group will prove also to have been pentadactyl, though even as early as the Bridger some genera had been reduced to a didactyl condition.—W. B. Scott, Geological Museum, Princeton, N. J., Jan. 16, 1894.

MINERALOGY AND PETROGRAPHY.[1]

Globular Granite in Finland.—An occurrence of spherical granite is reported by Frosterus[2] from the southern and eastern portions of Borga in South Finland. In the midst of a number of knolls of red or gray microcline granite, is one in which spherical nodules are plentiful. Of the rock forming this knoll there are two varieties distinguished by the difference in size of their nodules. In one the nodules are small and consist of a light covered zone surrounded by a dark periphery composed of two or three concentric biotite shells. The kernel is a granular aggregate of oligoclase, some microcline, a little quartz, and considerable biotite toward the center. The rock enclosing the nodules is a dark gray granite in which quartz and microcline are more abundant than in the nodules. In the second variety of rock the nodules are large. Their kernels are like the small nodules described. Around these is usually a narrow band of feldspar and around this a zone of mica. The rock in which the spherules lie is a grayish red granitite.

After investigating carefully the relations of the minerals in the nodules to each other and the relations existing between the nodules themselves, the author concludes that the spherules existed as plastic bodies in the rock magma while this was still liquid. When in contact with each other the nodules are often distorted, whereas at other times they are broken across. It is believed that the mica and other more basic components first separated in the form of a shell enclosing some of the rock's magma, that afterward gave rise to the granular nucleus upon cooling. The nodules are thus looked upon as basic concretions, and since they are distributed through a few restricted areas only, they are thought to form basic "Schlieren." The author's article is well illustrated by several handsome plates.

The Inclusions in the Basalts of the Oberlausitz.—A further study of the granite inclusions in the basalts of Oberlausitz by Beck[3] adds a few items of information concerning the contact action between volcanic rocks and their included fragments. On the Hirschberg the granite inclusions in nepheline-basalt have had pro-

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.
[2] Minn. u. Petrog. Mitth., XIII, p. 177.
[3] Minn. u. Petrog. Mitth., XIII, p. 231.

duced in them spinels and augite. The dyke melilite-nepheline-basalt near Kemnitz becomes porphyritic around the inclusions. Spinels and augite are again the principal new products formed in the granite, but in addition to these glass nodules containing chalcedony and tridymite are also found in the inclusions. On the basalt side of the contact nepheline is lacking and feldspar takes its place, while the olivine of the original rock is broken and corroded. Around a few of the inclusions a mineral of the hauyne group has developed. The nepheline-basalt of the Spitzberg near Paulsdorf, contains a very large number of included fragments, around which the course of the contact processes may be easily studied. Around some of them is an isotropic glass containing microlites and trichites, while one large inclusion made up of many fragments is discovered under the microscope to have its pieces cemented by glass in which are feldspar and quartz fragments, and now and then small crystals of augite forming 'crowns' around the quartzes, besides biotite, granular colorless olivine and crystals of cordierite, which are always associated with magnetite. As the distance from the inclusion increases, the quartz and feldspar gradually disappear, augite increases in quantity and olivine of the basalt type becomes prominent. The rock then differs from the normal nepheline-basalt mainly in containing feldspar and in the absence of nepheline. Of course, at a greater distance from the inclusion, the rock assumes its normal composition.

Thermometamorphism around the Shap Granite.—In a paper published some two years ago and abstracted in the Bulletin of the Geological Society of America[4], Messrs. Harkes and Marr[5] discussed the interesting effects produced upon andesite and rhyolitic lavas and tufas and upon limestones and slates by the intrusion through them of a great mass of granite at Shap Fell, in the Lake District, England. The same gentlemen return[6] to their study in a late paper, supplementing and correcting their former statements. They find in addition to the andesites and rhyolites, sheets of basalt or of a very basic andesite, containing monoclinic and orthorhombic pyroxenes, and like the other lavas characterized by an abundance of vesicles filled with products of weathering. These have suffered contact alteration to a greater extent than have the primary constituents, though all have

[4] Bull. Geol. Soc. Amer., Vol. III, 1892, p. 16, cf. AMERICAN NATURALIST, 1892 p. 847.

[5] Quart. Jour. Geol. Soc., XLVII, 1891, p. 266.

[6] Quart. Jour. Geol. Soc,, 1893, XLIX, p. 359.

been affected near the contact with the granite. Green hornblende, brown mica, colorless pyroxene, epidote and sphene are the most conspicuous new minerals formed. These lie in a clear, granular mosaic, which may consist of newly developed quartz and feldspar. The components of the vesicles have in most cases given rise to a mixture of hornblende and quartz, but in other cases a little calcite may remain unaltered in the center of larger vesicles, while surrounding it are usually hornblende, colorless pyroxene, quartz and epidote, and sometimes in addition, zonal garnets, sphene and a few other minerals. The feldspar found within the vesicles of metamorphiosed andesites is thought by the authors to be the result of the weathering of these rocks rather than a product of contact action. In concluding their paper some interesting thoughts are suggested as to the source of the materials producing contact minerals. It is known that limestones when pure may recrystallize as marbles without the production of contact minerals, but that when impure the silica in the impurities may (and generally does) release the carbonic acid and recrystallize with the calcium as silicates. In some of the vesicles of the rocks around the Shap granite, however, the calcite has recrystallized, with the formation of silicates only around the edges of its mass, proving plainly that silica was obtained for the production of the silicates only by the calcite immediately in contact with the silicates. The conclusion is that in cases of thermometamorphism no transference of material takes place within the mass of the altered rocks except between closely adjacent points. In the production of the lime silicates studied, the interchange of lime and silica is estimated to be limited to a distance of $\frac{1}{20}$ of an inch. Other observations indicate the correctness of this conclusion.[7]

Petrographical News.—In the Obersweiler gneiss of north Vogesen are dykes of basic rocks that Andreae and Tenne[8] identify as hornblende kersantites. They consist of a panidiomorphic aggregate of plagioclase, green hornblende, a little mica, quartz, apatite, etc. Other dykes of the region are quartz-melaphryes of the navite type. The quartz is undoubtedly original. Its grains are much corroded and the resorption rims around it are composed of augite and glass. The rock is interesting as the first recorded example of a dyke rock corresponding to the volcanic quartz-basalts.

The porphyritic granite of northern Lausitz contains large numbers of apatite crystals, sometimes as many as a hundred in a single

[7] See also Journ. of. Geol., Vol. I, p. 574.

[8] Zeits. d. deutsch. geol. Ges. 1892, p. 824

thin section. As large as is this number it is exceeded in sections of the basic concretions of the rock from Niedersteina. These concretions according to Hermann[9] are made up largely of hornblende and cordierite, and thousands of apatites, sometimes reaching 1200 in a single section. The interesting features of these apatites is not, however, their number, but their forms. In many cases they are skeleton crystals whose many branches are parallel like the teeth of a comb.

The Hour-Glass Form of Augite.—This well known form of augite, according to Blumrich,[10] is usually connected with zonal growth in the mineral, and is limited in its occurrence to the pyroxene of alkaline rich magmas. It is found not only in augite, but also in other minerals forming colored isomorphorus mixtures. The hour-glass form owes its existence to the fact that different crystallographic faces in a growing mineral attract molecules of different chemical compositions, which by addition to the attracting faces build out these faces with differently colored substance. The structure is certainly not due to the filling in of the outlines of skeleton crystals, as has often been assumed. Zonal bands extend uninterruptedly through both dark and light areas in the crystals, hence the materials of both must be of the same age. The one cannot have been a later deposition than the other. Pelikan[11] in confirmation of Blumrich's view, calls attention to the fact that if strontium nitrate crystals be allowed to grow in certain colored solutions, they become colored in areas distributed in accordance with the faces by which the crystals are bounded. The central cores of chiastolite crystals, Becke ascribes in a similar manner to the attractive influence of the end faces of the crystals upon the material added during growth.

The Effect of Impurities in Crystallizing Solutions.—It has long been known that the habit of crystallization assumed by a substance depends in large measure on the medium from which it crytallizes. Araganite, for instance, will separate from certain solutions, while from others calcite is precipitated. Vater[12] has conducted a series of experiments with calcium carbonate, allowing this substance to crystallize from various solutions under different conditions; and has reached some interesting conclusions. The ground rhombohedron

[9] Neues Jahrb. F. Min., etc., 1893, II, p. 52.
[10] Minn. u. Petrog. Mitth., XIII, p. 239.
[11] Ib. XIII, p. 258.
[12] Zeits. f. Kryst. XXI, p. 433 and XXII, p. 209.

of calcite separates from all solutions of pure carbonate in dilute carbonic acid at low temperatures. In general, under different conditions of formation, differently habited crystals are produced. Moreover, different proportions of impurity in the solution affect differently the resulting crystals, as well as the rapidity with which they grow. Contrary to the prevalent belief, however, the presence of calcium bicarbonate in a solution of the mono-carbonate exerts but little influence upon the complexity of the calcite crystals formed. The article is long, and is a thorough discussion for the subject treated.

North Carolina Quartz Crystals.—Gill[13] supplements Von Rath's study of North Carolina quartz crystals by describing some new forms and giving the results of etching spheres made from simple left-handed crystals with hydrofluric acid and hot sodium carbonate. The conclusions of his crystallographic study are to the effect that the mean of the measurements of 38 crystals give an axial ratio $a : c = 1 : 1.1018$. This ratio, which is larger than usual for quartz, is ascribed to the lengthening of the c axis brought about by impurities included within the crystals. All the crystals investigated were smoky quartzes, whose axial ratio approaches that of the Swiss crystals, and is larger than that of the Riesengrunde occurrences (1 : 1.0996). The crystallazition is trapezohedral-tetartohedral, which may be best regarded as *a combination of trapezohodral hemihedrism* and hemimorphism with respect to the lateral axes. The author notes the effect of various influences upon the development of the planes observed on quartz, and closes his paper with a discussion of crystal structure. The properties of quartz are explained upon the assumption of a molecule of SiO_2 in which Si is in the center of a regular tetrahedron, from whose upper and lower edges the oxygen exercises its influence.

Two New Books.—Hatch's mineralogy[14] is an elementary text book for the use of beginners in the study of minerals. The book begins with a very elementary treatment of the systems of mineralogy based in the notion of symmetry. It defines the terms made use of in describing the physical properties of minerals and ends with seventy-five pages on systematic mineralogy. The classification used is an arbitrary one—the rock-forming minerals being first discussed, then the ores, next the salts and other useful compounds and finally the

[13]Zeits. f. Kryst., XXII, p. 97.

[14]Mineralogy by F. H. Hatch, London, Whittaker & Co., 1892. Pps. viii and 224. Ills.

gems. The descriptions are clear but very brief and the illustrations in the text are well selected. The little volume is one of the best of its kind, though this is but scant praise.

Gregory's translation[15] of Loewinson-Lessing's Tables for the Determination of Rock-Forming Minerals, adds another to the number of books thut are supposed to aid the student in the rapid determination of the most common constituents of rocks. The tables are intended to lead their user to the *name* of the mineral whose characteristics he has observed under his microscope. It is a "guide to the identification of minerals, rather than a summary of their properties." The plan made use of in the construction of the tables reminds one of the schemes familiar to the determinative botanist. Habit, color, lustre, character of double refraction, etc., serve to place the minerals in different groups, from which one whose name is sought is selected by its special characteristics. The tables appear to fill a want, but only constant use in the laboratory will prove whether or not they will assist the student to the extent hoped by the author.

Mineralogical News.—*Azurite* with the habit of Chessy crystals and large *cerussites* prismatic in the direction of the brachydiagonal are mentioned by Molengraff[16] from Willow's silver mine near Pretoria in the Transvaal. On the former the three new planes $\frac{1}{10}\breve{P}\infty$, $-2\breve{P}3$ and $\frac{1}{3}\breve{P}3$ occur.

On three highly modified crystals of *phosgenite* from Monte Poni, Sardinia Goldschmidt[17] has discovered the new forms $P\frac{3}{2}$ and $3P\frac{3}{2}$ The distribution of the more common faces seems to point to a trapezohedral symmetry for the crystals, but no circularly polarizing effects could be detected in them. The axial ratio determined from the mean of the best measurements is $a : c = 1 : 1.0888$.

An analysis of *jarosite* from the cavities of the auriferous quartzite of the Buxton Mine, Lawrence Co., S. D., has been made by Headdon.[18] His results are:

SO_3	As_2O_5	Fe_2O_3	CaO	Na_2O	K_2O	H_2O	Total
30.29	2.51	49.28	.42	4.62	1.57	11.24	= 99.93

[15]F. Loewinson-Lessing's: Tables for the Determination of Rock-Forming Minerals. Translated by J. W. Gregory, With a chapter in the petrological microscope. London & N. Y., MacMillan & Co., 1893. Pp. 55.

[16]Zeits. f. Kryst., XXII, p. 156.

[17]Ib., XXI, p. 321.

[18]Amer. Jour. Sci., XLVI, 1893, p. 24.

Three fragments of *powellite* have been obtained by Koenig and Hubbard[19] from the south Hecla copper mine in Houghton Co., Mich. The mineral has a density of 4.349. Its composition was found to be:

MoO_3	WO_3	CaO	MgO	Fe_2O_3	SiO_2	Cu	Total
67.84	1.65	27.30	.16	.96	1.52	tr	= 99.43

Native *lead* is reported by Kempton[20] as occurring in thin scales and pellets, some of which approach rectangular forms, in a gangue of pyroxene of a pale green color. It is associated with iron oxides and calcite. The location given is near Saric, Sonora, Mexico.

Methods and Instruments.—Federow[21] in a recent article elaborates a new universal method for the measurement of crystals, suggests a new system for crystallographic nomenclature and illustrates a new method of projecting crystal planes, and determining by graphical means their symbols. The universal goniometer used in his investigations is described at length and pictured in detail. The author illustrates also the application of his method to studies in optical crystallography. He describes two models of universal microscope stages, constructed for the purpose of enabling the observer to revolve the object under investigation in two directions. The plagioclases are studied and it is shown that the labor of determining their nature is much reduced by the method of work suggested by the author. The paper is an important one and and one well worthy of close study.

Czapski[22] suggests the use of the iris diaphragm between a condenser of moderate strength and the stage of the microscope for the rapid interchange of parallel and converged light, and also the use of the same appliance in the ocular tube of the instrument for the isolation of the axial figures of very small crystals.

G. Friedel[23] gives a new method for determining the value of the double refraction in thin sections of minerals that seems to be simple in its application.

Goldschmidt[24] and Jolles[25] discuss two proposed methods for projection of crystal forms. Jolles article is illustrated by five plates and sixty figures.

[19]Ib., XLVI, 1893, p. 356.
[20]Science, June 23, 1893, p. 345.
[21]Zeits. f. Kryst., XXI, p. 574 and XXII, p. 229.
[22]Ib., XXII, p. 158.
[23]Bull. Soc. Min. Franc., XVI, p. 19.
[24]Ib., XXII, p. 20.
[25]Ib., XXII, p. 1.

BOTANY.

The Number of Plants.*—It is a question of science, and, if one will, also of reasonable curiosity, to ascertain approximately at least, how many are the plants which live upon the surface of our globe. And, in fact, almost every work of general botany devotes some attention to this subject. It is indeed true that the criterion of "species" is not equal for all botanists, some having a tendency to reduce, others to multiply (on the ground of very minute differences) the number in existence. The middle criterion of Linnæus, however, prevails by great length, which, somewhat improved, predominates in the classical works of De Candolle, Bentham, Hooker, Grenier, Godron, Koch, Asa Gray, Parlatore, Caruel, etc., etc. Admitted, however, some discrepancy in this criterion, the effect would be almost insignificant in comparison with the immense number of plants. Without enlarging too much upon the successive increases which the researches of the diligent have brought to the number of plants, I will sum up these results in a chronological table:

500–400 B. C.	Hippocrates reckons	234 plants.
310–225 B. C.	Theophrastus "	500 "
77 A. D.	Dioscorides "	600 "
23–79.	Pliny "	800 "
1650.	Caspar Bauhin "	5,266 "
1704.	Ray "	18,655 "

between species and varieties.

1771. Linnæus (see. Richter Cod. Linn.) reckons 8,551 species, of which 7728 are Phanerogams and 823 Cryptogams.

1807. Persoon (Syn. Plant.) reckons 20,000 species of Phanerogams.

1819. P. De Candolle (Theor. El.) reckons 30,000 species of Phanerogams.

1824. Steudel (Nom. Bot. I Ed.) reckons 70,000 species of Phanerogams and Cryptogams.

1841. Steudel (Nom. Bot. II Ed.) reckons 78,000 species of Phanerogams.

1845. Lindley (Veg. Kingd.) reckons 79,837 species of Phanerogams.

1885. Duchartre (Elem. Bot.) reckons 125,000 species, of which 100,000 are Phanerogams and 25,000 are Cryptogams.

* By P. A. Saccardo, translated by Roscoe Pound.

If we wish however to distribute the number of plants according to the principal groups and on the basis of the most recent monographic works, we arrive at the following result:

	NO. SPEC.	
Dicotyledons	78,200	See Durand Index Gen. Phan. 1888.
Gymnosperms	2,600	where the numbers are taken from
Monocotyledons	19,600	Bentham and Hooker Gen. Plant. 1862-1883.
Ferns	2,685	See Hook. and Bak. Syn. Filic. 1868-74.
Equis. Marsil. Lycopod.	565	See Baker Fern Allies 1887.
Mosses	2,303	See Mueller Syn. Musc. 1849-51.
Liverworts	1,641	See Gott. Lind. Nees, Syn. Hep. 1844.
Lichens	5,600	See Krempelhuber Gesch. Lich. 1870.
Fungi	11,890	See Strienz Nom. Fung. 1862.
Algae	6,200	See Kutzing Spec. Alg. 1849.
Total	131,104	

But this number (131,104) is greatly increased by recent and vigorous contributions made especially in the vast field of the Cryptogamia in consequence of the improvements made in the microscope and the increased number of observers. In fact, according to Underwood, the American hepaticologist (cfr. Bot. Gaz. 1892) from 1844 to the present time the number of Liverworts by researches made in more regions of the world has doubled. And as for the Algae according to my learned colleague, G. B. De Toni, upon documents collected by him and in part published in his admirable Sylloge Algarum, the number of species described up to to-day is distributed as follows:

	NO. SPEC.	
Chlorophyceae	2,798	(Syll. Algar. Vol. I, 1889.)
Cyanophyceae	800	about.
Phaeophyceae	1,100	"
Florideae	2,100	"
Bacillariaceae (Diat.)	5,000	(Syll. Algar. Vol. II et seq.)
Characeae	200	
Total	12,178	

Whence it appears that this vast group, too, has doubled since 1849.

Then in regard to the Fungi the results obtained in the active and multiplied researches of the last twenty years have surpassed all expectation. The number of species, in fact, reported in Vol. X of my Sylloge Fungorum and which goes to May of the current year, 1892, attains the marvellous sum of 39,663, that is to say, that in thirty years the group of Fungi has almost quadrupled.

We should therefore join to

Sum Total	131,104 (above indicated)
For the Liverworts	1,400
For the Fungi	27,773
For the Algae	5,978
and we have	166,255

This sum is deduced from positive data and it is annoying that on the other vegetable groups there is no information summing up the latest additions. However, to judge from the most recent botanical periodicals, as the Botan. Jahresbericht, the Botan. Centralblatt, the Monographiae Phanerogamarum, etc., etc., one cannot deny that the Mosses[1] have doubled since 1851 and that the Phanerogams and Ferns have increased almost five per cent.[2]

Thus we shall have:

Sum total preceding	166,255
For the Phanerogams an increase of	5,011
For the Ferns	134
For the Mosses	2,306
Total	173,706

Which sum, then, represents with great approximation the true number of species of plants known up to the present time, that is 105,231 Phanerogams and 68,475 Cryptogams thus distributed:

[1]The celebrated bryologist Schimper in the preface to his Synopsis Muscorum 1860-1876, thought that the Mosses of the whole world, when known, would amount to more than 8,000 species.

[2]The publication of the new and great Nomenclator Plantarum is eagerly awaited, already in part printed at London by the munificence of Darwin. From this one will be able to state exactly the real increase of the Phanerogams in these last years.

	NO. SPEC.
Phanerogams	105,231
Ferns	2,819
Equis., Marsil., Lycopod.	565
Mosses	4,609
Liverworts	3,041
Lichens	5,600
Fungi	39,603
Algae	12,178
Total	173,706

When we consider the many regions which still remain to explore or are imperfectly explored, it is beyond doubt that the number of plants will still increase very greatly. And one may be certain that it will be the number of the cellular Cryptogams which will receive the greater increase, as compared with the higher plants. In fact the perfections of the microscope which permit the convenient study of these most minute productions are, we may say, of yesterday, and the prodigious conquests of these last years, accomplished above all in the field of the Cryptogams are proof of this.

But the chief design that moved me to write this short note regards the probable number of Fungi to appear. From a few hundred forms which were known at the beginning of the century we have jumped, as has been seen, to about 12,000 species in 1862, and to-day we have nearly 40,000 of them. An astonishing progression, which is not explained solely by the increase of investigations, but reveals the enormous and scattered mass of fungous forms. It has been objected by several botanists that the specific autonomy of many Fungi is not founded on a secure basis and that many such species are rather to be considered as "forms of substratum", that is variations of the same species by reason of the different substratum or matrix in which they grow. I do not wish to deny that several admitted species may find themselves in this situation, but it is to be observed that in beings for the most part simple and microscopic the differential characters cannot be of great importance to our eyes, and hence it is necessary to go slowly before refusing them as good, as one must observe principally their constancy.

After all, on the subject of these suspected forms of substratum, this is a fact worthy of much consideration, that we very often see upon the identical living matrix several species of the same genus maintain themselves, most distinct, although related, as happens, e. g., in the

genera Sphaerella, Diaporthe, Leptosphaeria, Pleospora, Phoma, etc., etc. If the matrix had acted to modify the characters of Fungi, why should we find mingled together on the same branch, on the same leaf, two Diaporthes, two Sphaerellas, perfectly distinct? I am therefore convinced that a reduction of species will have without doubt to be made, but always with great caution, retaining also on this subject the just precept: melius est distinguere quam confundere.

In the number of the Fungi are comprised also the so-called imperfect forms (Sphaeropsideae, Melanconieae, Hyphomyceteae) which amount to about 10,000 species. These, in the judgment of some mycologists, ought to be excluded from the census of species; but this does not seem just, because, if for some few we know for certain that they form part of the metagenetic cycle of known perfect forms, it is more certain still that of the greatest part we know nothing positively of their metagenesis and are able to suspect that they are permanent forms of which the perfect state either has disappeared, or is wanting or is very rare. Why then should we exclude from the census of fungi beings distinct and constant?

We have seen that in only thirty years the number of fungi has increased by almost 28,000 species. I may add that an increase of certainly 8,100 species belongs to the brief period from 1882 to 1890 (cfr. Suppl. Syl. Fung.) in spite of the fact that my Sylloge Fungorum was published contemporaneously, a repertorium of all the Fungi hitherto described. Now we ask ourselves: to what results will the already well-begun mycological researches lead us when we have extended them to the whole world and to all fungus-bearing hosts? Some example can perhaps enlighten us a little on this journey still to be made. One of the best known regions (although not perfectly) in respect to the Phanerogamic flora more than the Cryptogamic, is without doubt the Venetian region. In this, according to the enumeration made by the well known Professor De Visiani in his work of 1869 (Catalogo delle piante vascolari del'veneto) we have 2939 Phanerogams, a number which even to-day remains almost unchanged. For the Cryptogams we have the accurate work of the G. Bizzozero published in 1885 (Flora Veneta Crittogamica, Ven. 1885), where the Venetian Cryptogams amount in all to about 6,000 of which 4,200 are fungi, a number raised now to about 4,800 by the researches of Professors A. N. Berlese, C. Massalongo, etc.

If the number of Venetian Phanerogams studied diligently from more than a century ago till our own time could not with new studies increase more than a very small number of species, it is positive that

the number of fungi will increase considerably. In fact the Venetian Hymenomycetes were until now scarcely studied and the interior provinces like those of Venezia, Rovigo, Vicenza, Belluno, Udine, which comprise the Alpine region which will give us without doubt a large contribution of new forms, are in a mycological respect almost entirely unexplored. I am therefore convinced that when all the Venetian territory is well explored, we will have at least 7,000 fungi in its Flora, a number which compared to that of the Phanerogams (2,939) surpasses it by certainly $\frac{3}{4}$. According to this proportion if we have today more than 105,000 Phanerogams in all the world, the fungi in order to exceed them by $\frac{3}{4}$ ought to ascend to about 245,000. This calculation cannot be accused of exaggeration when we see that the greatest part of the fungi being parasites, a connection between them and the hosts (for the most part Phanerogams) must necessarily exist.

But this is not all. We have rich and accurate repertoria of fungi according to their hosts; as the general one of Westendorp, the one for Venice of Cuboni and Mancini; the very recent one for North America of Farlow and Seymour. A glance at these repertoria shows us at once that there are very many Phanerogams which harbor parasitic fungi by tens and hundreds many of which are exclusive to them. We have moreover careful monographs of the fungi which grow upon the vine (Pirotta, Thuemen), on the Lemon and Orange (Penzig), on the Mulberry (Berlese). Now the fungi which grow upon the vine are according to the last census of Thuemen (1892) in number 595, those on the lemon and orange 190, those on the mulberry 200. When we consider these hosts as generic groups (Vitis, Citrus, Morus) and calculate that for each of these groups alone, on an average, 40 per cent. of the parasitic fungi are exclusive to them (and not wandering or pantogenous) we have: for the genus

Vitis, proper species of fungi	238
Citrus	76
Morus	80

the average of which numbers is 131. Now the genera of greater plants of Phanerogams being, according to Bentham and Hooker 8,417, if we reckon 131 fungi proper for each one of these genera, there results the huge cypher of 1,102,627 parasitic fungi, to which must be added that of terrestrial and non-parasitic (about 11,000) in all 1,113,627. Certainly this number does not appear at all impossible when we think that the data are taken from genera (Vitis, Citrus, Morus) which contains few species in comparison with others (e. g. Solanum, Astragalus, Euphorbia) which possess several hundred more of them, which with-

out any doubt have peculiar fungi. Nevertheless reflecting that several species or groups of plants are notoriously attacked by a less number of fungi; that in certain regions of the globe, whether because of dryness, or because of the scarce vegetation parasitic fungi are also rare;[3] finally that woody natures, as the three taken for data, are habitually more attacked by parasitic fungi than the herbaceous, I believe I shall be held just and in every way conservative in calculating only thirty parasitic fungi, on the average, for each genus of Phanerogams. We have thus 252,510 species of parasitic fungi, which united to the recorded non-parasitis amount to a total of 263,510. The number of parasites (252,510) divided among all the known species of Phanerogams (105,000) would give us the reasonable number of a little more than two special fungi for each phanerogamic host, without counting that also the ferns, mosses, liverworts, and even the greater fungi, offer an asylum to not a few fungous parasites.

This calculation deduced from the number of fungi for each generic group of Phanerogams accords more than sufficiently with the calculation previously made from the connection of the number of species of Phanerogams and that of fungi in a given area well explored, in a way that makes it appear that the total number of species of fungi, perfect and imperfect, in the whole world ought to ascend at least to the neighborhood of 250,000, that is to say, a little more than six times the number we know to-day.

To summarize, we may conclude that the species of plants known and described up to the present time are about 174,000, divided into 105,000 Phanerogams and 69,000 Cryptogams, that is in the lump 50,000 more than were admitted even in recent works. As regards, then, the entire number of species which cloak our globe, by the calculations alone which I have previously explained regarding the fungeous vegetation, I think we shall not go astray in estimating that the Flora of the world when it is completely enough known, will consist of at least 385,000 species of plants (that is, 250,000 fungi and 135,000 species of the other groups). If one wish only to reduce to 15,000 the species which will appear in these other groups (not fungi) the sum total of plants would ascend to 400,000 species at least.

[3] Mycologic geography and statistics are still little advanced. However if we see Europe almost in every part rich in fungi, if we see Argentina and Brazil, Cuba and the United States, Australia and New Zealand, Siberia, Ceylon, and Algiers varyingly but yet always rich in fungi, this signifies that they are liberally diffused at least over a great part of the world.

When shall we come to know well this enormous number of plants? If since 1824 the sum of plants has jumped from 70,000 according to Steudel, to the modern sum of 174,000, that is in 68 years we have discovered 104,000 species, to arrive at a problematical 400,000 about 150 more years of research ought to run. Our remote grandchildren will see whether these prophecies are verified, or whether in this we are greatly in error.—P. A. SACCARDO. [In Atti Cong. Bot. Int. 1892. Translated by Roscoe Pound.]

New Book on Ferns.—A book on the "Study of the Biology of Ferns by the Collodion Method," by Professor G. F. Atkinson of Cornell University is announced for early publication It is to be fully illustrated from original drawings by the author, and will include in the descriptive portion a discussion of the development, morphology and anatomy of the gametophytic and sporophytic phases, while a second part deals with methods of study. The house of Macmillan & Co. is to bring out the book, which will be looked for with interest by laboratory botanists.—CHARLES E. BESSEY.

ZOOLOGY.

Reappearance of the Freshwater Medusa, Limnocodium sowerbii.—Mr. E. Ray Lankester reports finding well-grown specimens of *Limnocodium sowerbii* in the Victoria Regia tank of the Sheffield Botanic Gardens. This jelly-fish was first noticed in 1880 in Regent's Park, to which it had probably been transported from Brazil on the rootlets or leaves of a Pontederia. It was observed from year to year until 1891, when all trace of it was lost, and naturalists gave up the hope of carrying on any further investigation into its life history. Its appearance in Sheffield is accounted for by presuming that some reproductive germs were attached to the water plants sent from Regent's Park to re-stock the tank in Sheffield, April 4, 1892, and April 7, 1893. The curious thing is that in 1892 and 1891 no Limnocodium were seen in the original source, nor in 1893 except the few sent from Sheffield and placed there by Mr. Sowerby.

This beautiful little organism was first studied by E. Ray Lankester, who ascertained the following facts.

The jelly-fish appear suddenly each year as early as April or as late as August, and remain from five to twelve weeks, when they die down and absolutely disappear. When first seen they are extremely minute, $\frac{1}{10}$ of an inch in diameter, and gradually develop to the full size of half an inch in diameter. Of the many hundred specimens examined in successive years, every one without exception were males. They produced abundant motile spermatozoa, but not a trace of egg-cell has ever been found in any one of them.

In 1884 Dr. A. G. Bourne described a diminutive polyp, not more than $\frac{1}{8}$ of an inch long, devoid of tentacles which he found adhering to the root filaments of Pontederia in the same tank in which the Limnocodium was discovered. This polyp was supposed to be the "trophosome" of the Limnocodium medusa. That this inference was true was proved Dr. Fowler in 1890, who was fortunate in seeing the little spherical young found floating in the tank, nipped off by a process of transverse fission from the free ends of the minute polyps described by Bourne.

The next question, How do the polyps originate? has not yet been answered. They increase by budding, but never form colonies of more than four "persons."

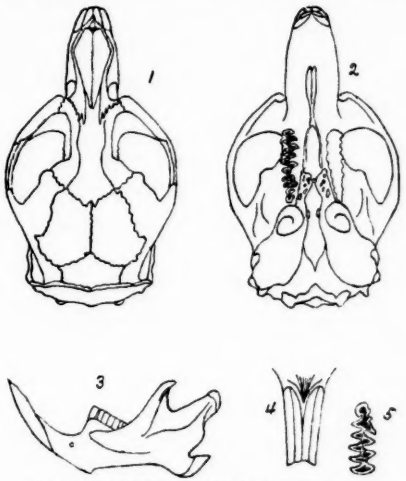
In conclusion, the author refers to the remarkable form worked out

by Mr. R. T. Günther during last winter, the *Limnocnida tanganyisiæ*, a fresh water jelly-fish from Lake Tanganyika. Individuals of three kinds are described by Mr. Günther, viz.: males, females, and asexual individuals which produce crops of buds on the manubrium While differing from Limnocodium in most respects, Limnocnida agrees with it in the minute structure of the marginal sense organs, According to Mr. Lankester no light is thrown by Limnocnida on the problem of the life history of Limnocodium. (Nature, Dec. 7, 1893.)

The American freshwater hydroid *Microhydra ryderii* Potts, is supposed to be a near ally Limnocodium.

Description of a New Genus and Species of Arvicoline Rodent from the United States, Rhoads, Gen. et. sp. nov. (Lake Kichelos, Kittitas County, Washington.)—AULACOMYS ARVICOLOIDES.—*Diagnostic Characters*—Skull large, massive, angular; malars parallel. Superior incisors long and slender (about equalling length of nasals), projecting anteriorly, strongly recurved and with flattened faces. A narrow, longitudinal sulcus equally divides the anterior face of each superior incisor, this groove, slightly magnified, showing a clear-cut, well-defined channel. To the naked eye this channel can be detected only on closest scrutiny. First lower molar with six angles on each side, two isolated triangles on the outer, and three isolated triangles on the inner side. On the inner side these are made up: 1, an inner posterior angle or shoulder of the anterior loop; 2, a rounded angle widely separated from the first but basally connected therewith by a continuous valley and reaching nearly as far from the median line as angle No. 3; 3, 4 and 5, large equidistant acute triangles of equal size, much larger and longer than opposing outer triangles and separated therefrom by a zigzag median line of enamel forming the alternating bases of opposing series of triangles; 6, the inner angle of posterior loop. Exteriorly the angles are formed as follows: 1. a rounded corner at the outer base of anterior loop; 2. a small angle abutting on the extended valley of anterior loop, said angle being anterior to plane of angle (No. 2) of the opposite side; 3. a rounded angle, widely separated from angle No. 2 of same side, due to the extreme posterior deflection of the crescent-like loop which angle No. 3 terminates; this loop is connected by a narrow valley with the anterior loop and in like manner with its preceding angle on the the same side and the two opposing angles, the five angles thus connected representing the four normally present in the anterior trefoil of recent *Arvicola, Evotomys, Synaptomys, Myodes* and *Cuniculus;* 4 and 5.

Two triangles of equal size, their bases formed by the median line of enamel connecting the bases of the three larger opposing internal triangles already mentioned; 6. A rounded angle of the posterior loop distinctly separated from its preceding triangle (No. 5) by full width



AULACOMYS ARVICOLOIDES, Type.

Explanation of Plate.—1. Skull, from above. 2. Same, from below. 3. Exterior of left Mandible. 4. Anterior view of superior Incisors. 5. Crown of right, lower first Molar. (Figs. 1, 2, 3 & 4 x 1½ diameters; fig. 5 x 2½ diameters).

of base of last inner triangle. The molar series are prismatic and non-rooted, Remainder of molar dentition much as in the genus *Arvicola*. Owing, however, to the greater relative depth and width of the entrant angles in *Aulacomys* the basal corners of opposing triangles of the lower molar series do not overlap as in *Arvicola* but stand distinctly upon their respective sections of the median enamel wall. Frontal bones flattened superiorly and lacking trace of supraorbital ridges. Nasals, short, abruptly triangular, terminating posteriorly in a point, very broad anteriorly and deeply notched subterminally. Nasal process of premaxillary, reaching behind anterior plane of orbits, far behind base of nasals and terminating in a slender point. Auditory bullae, triangular, narrow, not encroaching on basisphenoid, the tympanic process of the meatus (viewed from below) lying within lateral profile of the brain case. Postpalatal notch acute, terminating the hastate pterygoid fossa, so formed by the contraction of the pterygoids. Con-

dylar ramus short and heavy with strong posterior shoulder forming a knob at base of condyle, containing the greatly extended root of lower incisor. Coronoid process, stout, erect and triangular. Angle very short and massive.

Body probably stouter than in *Arvicola*. Tail over half the length of head and body, sparsely and evenly coated with short spines and terminated by a well-defined pencil of slender hairs. Feet five-toed, each with five tubercles; claws long and slender. Whiskers pronounced, the longest reaching behind ears.

Aulacomys has the superficial appearance of *Arvicola* but with a very long and apparently naked tail and heavy whiskers. Cranially, it combines the molar dentition of *Arvicola* with the incisor dentition of *Synaptomys*. In these very respects, however, it differs from both genera—from *Arvicola* in the five-angled formation of the anterior section of the first lower molar, and from *Synaptomys* in the length, narrowness, protrusion and *central* sulcation of the upper incisors, also in the extension of the roots of the lower incisors far beyond the last molar.

The dentition of *Aulacomys* shows, in the number of angles of the anterior lower molar, an approach to the extinct form, *Arvicola* (*Anaptogonia*) *hiatidens* Cope, from the bone caves of Pennsylvania[1] but differs radically from it in the isolation of the triangles.

The absence of supra-orbital ridges, the posterior prolongation of the nasal premaxillary processes beyond nasals, the acute post-palatal notch, the shape of the pterygoid fossa and the massiveness of the posterior members of mandible are all, in a greater or less degree, diagnostic of *Aulacomys* as distinguished from other Arvicoline genera.

Specific characters.—Type, No. 1358; Ad., ♀. Col. of S. N. Rhoads, Lake Kichelos, Kittitas Co., Washington [Alt. 8,000 ft.], September, 1893. (Col. by Allan Rupert.)

Description.—Characters as decribed for genus. Above, reddish-brown, lined with black. Pelage, basally, everywhere plumbeous. Below, hoary plumbeous, lightest on throat. Upper parts of feet blackish. Tail very slightly darker above, than below. Ears not prominent, well-haired on both sides and with distinct valvular antitragus. Whiskers black.

Measurements (taken in flesh by collector).—Total length.—197;[2] tail 70; (taken from damp, relaxed skin), hind foot 27; ear 10; pencil 7.

[1]Proc. Soc. Amer. Philos. 1871, P. 91.

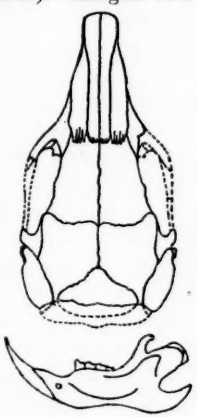
[2]Millimeters.

Skull.—Basilar length 29; total length (occipito-nasal) 31; zygomatic breadth 19; nasal length 9; interorbital constriction 5; interparietal breadth 7; interparietal length 4.9; crown length of molar series 7.4; greatest depth of cranium 10.9; length of mandible 20; height of coronoid process 11; ratio of zygomatic breadth to basilar length 65.5; zygomatic breadth to occipito-nasal length 58.

The specimen on which the foregoing characters are based was taken near Snoqualmie Pass on the Cascade Mountains. Out of a large series of rodents from this district it is the only specimen of its subfamily. It arrived in the form of a flat skin, reversed, with the skull separate and intact.—SAMUEL N. RHOADS.

Description of a New Perognathus collected by J. K. Townsend in 1834. PEROGNATHUS LATIROSTRIS. Sp. Nov.—Type, No. 694, ad ♂, Col. of Acad. Nat. Sci. of Phila.; "Rocky Mountains, J. K. Townsend;" Summer, 1834.)

Description—(mounted specimen, lacking tail, once preserved in spirits).—Largest known species of the genus. Upper half of head and body to root of tail, brownish-yellow, interspersed medially with black, spinous hairs, becoming purer brown on sides and bordered laterally from base of nose to tail with a broad ill-defined line of pure fulvous. No black tips to brown hairs of back, all hairs being unicolor from root to tip; black hairs coarsest. Pelage long and coarse throughout. Whiskers, slender, sparse, the longest reaching far behind the ears. Lower parts, feet, forelegs to shoulder, and inside of hind legs, dirty white. Ears pronounced, rounded, rather sparsely haired, with marked antitragus not higher than broad at base. Hind ears and spot over eyes fulvous. Hairs of base of tail same color as under parts all round point of fracture, seeming to indicate a unicolor tail. Soles hairless along median line to heel. Cheek pouches very large, external opening of same stretching from upper incisors half way to forelegs.



Perognathus latirostris, Type. (Enlarged one and two-sevenths diameters.)

Skull—(occipital and postero-mastoid region absent); cranium deep, slightly arched, as viewed from above, subrectangular; rostral portion very wide; interparietal bluntly mucronate anteriorly; coronoid pro-

cess erect, abruptly recurved near the blunt tip, anterior width of nasals nearly twice that of posterior width; a broad supraorbital furrow laterally borders the brain case from the lachrymals to the mastoid side of parietals, audital bullae separated anteriorly by full width of basi-sphenoid, molariform dentition as in *P. paradoxus*.

Measurements—(from mounted specimen); length of head and body 145; hind foot (shrunken), 27; ear from crown, 6.

Skull.—total length (approximate) .35; tip of nasals to interparietal 28.4; base of incisor to anterior tip of audital bullae 18; zygomatic width (at outer bases of squamosal process of malar) 17.5; interorbital constriction 8.8; length of nasals 14; nasal width (near tip) 4.2; nasal width (near base) 2.2; interparietal width 8.2; crown length of upper and lower molar series 4.6; length of median parietal suture 5; greatest parietal length (masto-squamosal) 10; length of mandible (inner base of incisors to condyle) 17.4; height of coronoid process from angle 8; greatest depth of cranium 11.

The specimen from which the above description is taken was collected by J. K. Townsend during his memorable Rocky Mountain journey nearly sixty years ago. It has been exhibited in the museum of the Academy during the greater part of that period and has lost its tail in the service. The locality given on the present label is only approximate, if correct at all, as an earlier entry of the specimen (probably copied from the original one) in the catalogue gives the specimen as "694, Thomomys rufescens, yg., J. K. Townsend, Columbia River." This name was, a long while ago, altered to "*Perognathus fasciatus*," as the museum label now stands. Probably the person making the last identification changed the given habitat to "Rocky Mountains" to accord with the habitat assigned to *fasciatus* by Baird. The specimen was probably taken east of the 34th meridan and south of the 43rd parallel, in Nebraska or Wyoming. It is not impossible that it came from a more western region. Its differentiation from its nearest ally, *P. paradoxus*, indicates a different faunal habitat from that occupied by the latter. Dr. Townsend makes no mention of the genus *Perognathus* in his list of the mammals observed during his journey, nor does Dr. Bachman, in his supplementary list of novelties published in the Journal of the Academy of Natural Sciences. It is possible that the specimen, owing to its mutilated (tailless) condition and being put in alcohol, was hastily overlooked, or classed as a young *Geomys* (the catalogue entry implies this), and later on it was mounted as such.

The specimen is over-stuffed, but does not appear unduly stretched laterally. From its appearance and the dimensions of its skull it is

evidently a larger species than *paradoxus*, the largest of the genus hitherto known. In many respects, notably of the dentition and general proportions of the brain case, and in size and coloration, *latirostris* resembles *paradoxus*, but is strikingly different in the size and proportions of the rostrum and of the interparietal. Owing to the loss of occipital portions I am unable to give the usual ratios for sake of comparison with Dr. Merriam's tables. *Perognathus latirostris* belongs to the *paradoxus* group of the subgenus *Chætodipus*.—SAMUEL N. RHOADS.

Zoological News.—MOLLUSCA.—The experiments in oyster culture carried on at Roscoff, France, have been extremely satisfactory. In a communication addressed to the Academy of Sciences at Paris, M. de Lacaze Duthiers gives a detailed statement of what has been accomplished. The spat were planted in a closed fish pond so situated that at high tide the sea water could find entrance. The young oysters grew rapidly, and in three years, that is to say the fourth year of their age, they were well grown and fine in flavor. During this year, young were produced in large quantities, thus settling the question of the age for reproduction in the oyster. (Péches Maritimes, T. I, 1893.)

ARTHROPODA.—Mr. Walter Faxon reports 105 new species of Crustacea, some of which represent new genera, in the collection obtained by Mr. Agassiz in the dredging carried on by the U. S. Fish Commission Steamer, "Albatross," off the west coast of Central America and Mexico and in the Gulf of California, during 1891. (Bull. Harvard Mus. Comp. Zool., Vol. XXIV, 1893.)

According to Dr. C. O. Porat, the Syrian Myriopods collected in 1890 by Dr. Barrois comprises 19 species, many of which are new, distributed among 10 genera. In its general aspect this Syrian fauna resembles that of southern Europe and northern Africa, being intermediate in its characteristics. The species are described and figured in Revue Biologique, Nov., 1893.

VERTEBRATA.—The report of the U. S. Fish Commission for 1889–91 contains a review of the Sparoid fishes of America and Europe, by D. S. Jordan and B. Fesler. The family comprises about 55 genera and some 450 species, all valued as food, chiefly inhabiting the shores of warm regions. The authors consider the group closely allied to the Serranidæ on the one hand, the genus Xenistius being very close to the Serranoid genus Kuhlia; on the other hand, Scorpis, Cyphosus, etc., approach the Chætodontidae. Of the 12 subfamilies into which the

group is divided, 3 are exclusively American, and 2 are confined to the Old World.

M. Leon Vaillant describes a new genus of fishes from the Caroline Islands of which there are now two individuals at the Paris Museum. This fish resembles Fierasfer of Cuvier, but differs from it in the size of the dorsal fin, and more particularly in the character and position of its scales. In the Caroline genus the scales are distinctly separate, large in proportion and form a sort of network with lozenge-shaped meshes over the body; they are not imbricated, but merely touch, end for end. It is this singular arrangement of the scales that leads Mr. Vaillant to create a new species to which he refers these fish with the specific name *Rhizœketicus carolinensis.* (Revue Scientifique, Dec. 1893.)

A list of the Mammals of Rio Grande de Sul published by Dr. Herman von Ihering shows the following distribution: Marsupialia 11; Diplarthra 8; Cetacea 2; Edentata 6; Glires 24; Chiroptera 17; Carnivora 19; Pinnipedia 2; Quadrumana 3. (Rio Grande de Sul, 20, IV, 1892.)

From certain cranial and dental peculiarities, Mr. C. Hart Merriam considers the Yellow Bear of Louisiana a species distinct from *Ursus americanus* Pallas and *U. horribilis* Ord. He gives a description based on five skulls from Morehouse Parrish, Louisiana, and claims for it the name *U. luteolus*, given by Griffith in 1821. (Proceeds. Biol. Soc. Wash., Dec., 1893.) He thinks it is the Cinnamon Bear of Audubon and Bachman, but of this there is much doubt.

Two new species are added to the list of Mammals from East Africa, a dormouse, *Eliomys parvus*, closely resembling *E. kellenii*, and a mouse, *Mus tana*, allied to *M. musculus*. Both species are described by Mr. Frederick True in the Proceeds. U. S. Natl. Mus., 1893.

ENTOMOLOGY.[1]

North American Proctotrypidæ.—Mr. Wm. H. Ashmead furnishes in his Monograph of North American Proctotrypidæ,[2] one of the most important of recent descriptive works on American insects. In preparing the 457 pages of his text the author has had ample opportunities to work up our rich Proctotrypid fauna, studying in addition to the various American collections those of the Royal Museum of Berlin. Mr. Ashmead believes that the Proctotrypidæ are more closely allied to the Chrysididæ and Cynipidæ than to the Chalcididæ, next to which they are so commonly placed. He would separate the Mymarinæ as a distinct family allied to the Chalcids.

The lives of adult Proctotrypids are of short duration, not longer than four or five days in confinement, though probably longer under natural conditions. They occur in a great variety of situations, the favorite resorts of some being moist places where vegetation is luxuriant and insect larvæ abundant; others are found along the borders of woods or in the open fields; still others frequent fungi, and some occur in ant's nest. Comparatively few are found on flowers.

"There is scarcely any doubt but that many of the wingless forms to be found in various genera of this family are only dimorphic forms of winged species, although comparatively little is postively known on the subject." The eggs of these insects are "ovate or oblong in shape, with a more or less distinct peduncle at one end, and agree well in general with many in the family Ichneumonidæ, although those in the subfamily Platygasterinæ, on account of the longer peduncle, more closely resemble those in the family Cynipidæ." The larvæ are internal feeders, and in pupating plan for a protection of some kind.

"The Proctotrypidæ are apparent widely distributed over the whole world, although outside of Europe little is known of the exotic forms, and it is not possible therefore to generalize upon the genera and their distribution. From an examination of various exotic collections of Hymenoptera, it is safe to predict the species will be found to be numerous and widely distributed, but far less numerous than the Chalcididæ; judging from my own collecting I should say less than one-fiftieth in number. Only a small percentage of the species is yet described." The affinity of North American forms with those of

[1]Edited by Prof. C. M. Weed, Durham, N. H.

[2]Bull. 45, U. S. Natl. Museum, Washington, 1893.

Europe is shown by the way they fit into established European genera. South American species have required the erection of many new genera.

A large number of new species are described in the present monograph, which concludes with a full Bibliography and eighteen original plates illustrating structural details of members of the various genera.

Peculiar Oviposition of an Aphid.—During the autumn of 1890 I found a species of *Phyllaphis* on beech in central Ohio, the oviparous form of which agrees with Buckton's short description and figure of *P. fagi*. I presume that it is that species, but do not think the present evidence justifies a definite reference to that effect. The colonies were found on the underside of the leaves, with more or less flocculent matter about them. The sexed forms developed during October, and the oviparous females wandered over the bark of the twigs, limbs, and trunk in search of crevices in which to deposit their eggs. When a

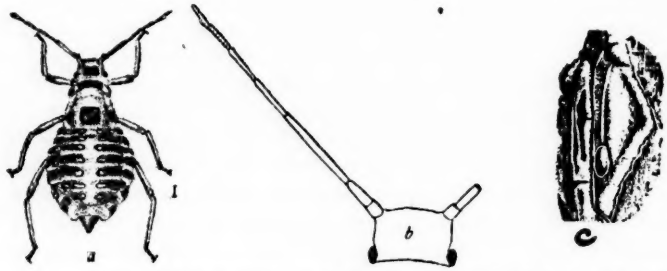


Fig. 1.—***Phyllaphis*** of beech: *a*, oviparous female, magnified; *b*, head and antenna of same, greatly magnified; *c*, egg on bark, magnified.

suitable place is found the egg is laid, and then driven into position by the following method: The insect so places itself that its hind legs easily touch the egg, then standing on its four front ones it brings the two hind ones down upon the egg in rapid succession, striking with considerable force. This serves the double purpose of pushing the egg in place, and of drawing out a viscid secretion, with which it is covered into a thread-like, silvery film, that so resembles the surrounding bark that it is difficult to detect it. I watched an oviparous louse go through this process for about a minute and a half.—*C. M. Weed in Trans. Am. Ent. Society, November*, 1893.

Pupal Development and Color in Imago.—Discussing the recent experiments of Merrifield in which lepidopterous pupæ were submitted to various temperatures and the results on the imagoes noted, Mr. J. W. Tutt briefly recapitulates[3] the well-known facts of histolysis and continues thus: "If we apply the simplest elementary laws relating to vital force to the pupa, we shall find that the following facts hold good:—(1). The pupa when first formed has a certain amount of inherent vital force by means of which both the processes of histolysis and rehabilitation are carried on in it. (2). That pupa which has the nearest approach to the normal amount of vital force will undergo the most perfect histolysis and rehabilitation, and will produce an imago most nearly conforming to what is known as the normal type, that is the type produced under the most healthy and satisfactory conditions. Conversely that pupa whose amount of vital force is farthest removed from the normal (whether in excess or in defect) is one in which histolysis and rehabilitation will be least perfect, and the imago produced will be the farthest removed from the normal type. (3). That individual which has been best fed and which had enjoyed the most perfect health in the larval stage, will enter pupal life under the most satisfactory conditions and will (the pupal conditions being equally satisfactory) emerge therefrom as the best specialized product, whilst the converse to this must also be true.

"The second point also deals with an elementary principle. The vital force in the pupa is converted into energy; the energy at the disposal of the pupa is most probably directed first to the building up of the vital reproductive organs, and afterward to the secondary organs or tissues or such as are not necessary to life. Therefore an excess of energy in a pupa will be expended as a rule on secondary structures rather than on vital ones, and we find that a weak or diseased pupa fails first in regard to non-vital tissues, such as pigment, scales, wing-membrane, etc.

"The females of insects, as compared with the males require an excess of energy for those structures necessary to the reproduction of the species; they, therefore, have a smaller surplus to devote to the formation of the non-vital tissues, and as we well know frequently fail very markedly in their development of these.

"We are now in a position to understand that as a general rule pigment, scales, etc., are produced in proportion to the amount of material and energy available for the purpose.

[3]The Entomologist's Record, IV, 312.

"These and other general principles have to be considered when we attempt to discuss the results which Mr. Merrifield produces by his temperature experiments.

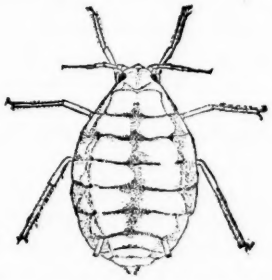
* * * "If now we apply these principles what do we find? Insects which are allowed to pass through their changes at the normal temperature produce the form which is normal for the district; that is they undergo the normal processes of histolysis and of rehabilitation, and in a state of health have at their disposal the energy requisite to give them their ordinary wing expanse, scaling and color. Now what does Mr. Merrifield do in his experiments? He subjects the pupa to a low temperature. This of necessity lowers the vitality of the pupa and so lessens the available energy. The insect therefore does not develop under normal conditions, and an abnormality is the result. The insect must use what energy it has to build up its vital organs, and fails in building up perfectly its secondary tissues—color, scales, wing membrane, and fails to in direct proportion to the degree in which the vitality is lessened. Below a certain temperature during the period of active development the vital force ceases to act at all, and the result is death. Heat, greater than that to which the insect is normally subjected, instead of lowering the vitality to the lowest ebb at which life can be sustained, affects the histolysis and rehabilitation in a directly opposite manner. Under its influence the vital processes are carried on at express speed. Energy is expended at the fastest rate possible, and the tissues are formed without having sufficient time to mature as they would under normal conditions, the surplus material is rapidly utilized, with the result that as marked an abnormality is produced under the one condition as under the other, although in an opposite direction."

Studying Insect Histories.—That the pursuits of the entomologists are not always so delightful as the chasing of June butterflies is shown by the following extract from a paper recently read by Mr. L. O. Howard before the Association of Economic Entomologists: To gain the clearest and most accurate idea of a life history, the insect must be studied under perfectly natural conditions, and not under conditions which more or less imperfectly simulate the natural ones. There is no easy road to the most perfect knowledge of habits. It involves tramping through mud and bramble patches; it involves the constant risk of sunstroke, and in our southern country the constant presence of Leptus and Ixodes (itch-mites and ticks); it involves constant watching and watching and watching, astride the small limb af a fruit tree,

perhaps, on your back under bushes, on your knees in the wheat-field, on your stomach in the pasture, with your face down close to a cow dropping, and with the summer sun beating down upon your unprotected head, watching and watching until the eyes grow dim; but in this way only are the unsolved problems in the life histories of injurious insects most satisfactorily worked out.

Biology of the Apple Aphis.—The common Aphis of the apple (*A. mali*) has for many years puzzled entomologists by its summer history. During June, usually, winged viviparous females leave the apple and disappear. In September other similar forms return to apple and give birth to the oviparous females which deposit the eggs on the twigs. In a paper on the insect foes of American cereals read at the recent meeting of the Association of Economic Entomologists, Mr. F. M. Webster of the Ohio Experiment Station gave a clue to the summer history in the following paragraph:

"It would appear almost visionary to advocate spraying apple orchards in midwinter to protect the wheat crop, but nevertheless one of the most serious enemies of young fall wheat passes its egg stage on the twigs of apple during the winter season. I refer to the Apple Leaf-louse (*Aphis mali* Fabr.), Soon after the young wheat plants appear in the fall, the winged viviparous females of this species flock to the fields, and on these give birth to their young, which at once



Apple Aphis; wingless viviparous female. Magnified.

make their way to the roots, where they continue reproduction, sapping the life from the young plants. On very fertile soils this extraction of the sap from the roots has no very serious effect, but where the soil is not rich, especially if the weather is dry, this constant drain of vitality soon begins to tell on the plants. Though they are seldom killed out right these infested plants cease to grow, and later take on a sickly

look, and not until the Aphis abandons them in the autumn to return to the apple, do they show any amount of vigor."

This leaves the summer period still unaccounted for, but in the discussion which followed Mr. Webster's paper, Dr. C. V. Riley stated that he had "for a number of years known that this species had a summer existence on various grasses."[4]

Nematodes in Cecidomyia.—At a recent meeting of the *Societè Entomologique de France*, M. A. Girard called attention to the observation of Kieffer[5] as to the existence of Nematode parasites in a female cecidomyiid (*Asynapta citrina* Kieff.). A fly of this species stupified by nitro-benzine emitted from the oviduct a compact mass of Anguillulas which placed in water moved about rapidly. Kieffer thought that the alimentary canal also contained these Nematodes, but Girard believes it to be a case where only the abdomen, especially the region of the ovaries is inhabited by the parasite. He reports a similar observation of his own, in which an undetermined cecidomyiid was the host. The body cavity was nearly filled with a Nematode of the genus Asconema and its embryos. The ovaries of the fly were atrophied by parasitic castration. The eggs of the Nematode developed in the body of the fly, and the latter laid the little Anguillulas in humid situations where they could develop.

Flights of Dragon-Flies.—In. Mr. W. H. Hudson's recently published *Naturalist in La Plata* there is an extremely interesting chapter on Dragon-fly Storms. In the Pampas and Patagonia, the larger species of these insects—especially *Æschna bonariensis* Raml., a pale blue form—frequently occur in enormous flocks which appear shortly in advance of a sudden and violent wind—called the *pampero*. "Inasmuch as these insects are not seen in the country at other times, and frequently appear in seasons of prolonged drouth, when all the marshes and water courses for many hundreds of miles are dry, they must of course traverse immense distances, flying before the wind at a speed of seventy or eighty miles an hour. * * * As a rule they make their appearance from five to fifteen minutes before the wind strikes; and when they are in great numbers, the air to a height of ten or twelve feet above the surface of the ground, is all at once seen to be full of them, rushing past with extraordinary velocity in a northeasterly direction. * * * * All journey in a northeasterly direction; and of the countless millions

[4]Insect Life, VI, 152.

[5]Berlin Ent. Zeitsch., XXXVI, 1891, p. 266.

flying like thistle down before the great pampero wind, not one solitary traveller ever returns."

These flights occur during the summer and autumn. Mr. Hudson thinks the cause "is probably dynamical, affecting the insects with a sudden panic, and compelling them to rush away before the approaching tempest. The mystery is that they should fly from the wind before it reaches them, and yet travel in the same direction with it.

* * * On arriving at a wood or large plantation they swarm into it, as if seeking shelter from some swift pursuing enemy, and on such occasions they sometimes remain clinging to the trees while the wind spends its force."

Mr. Hudson calls attention to Weissenborn's observation of a dragon-fly migration in Germany in 1839,[6] and his mention of similar flights in 1816. These occurred in May and the insects flew south.

An autumn flight of dragon-flies among the Alps has been described by W. Warde Fowler[7] whose attention was called to the flight by a waiter in an Alpine hotel. The latter had "observed a constant stream of dragon-flies making their way up the valley; and during my walks that day I was able fully to verify his statement. All the way from Haspenthal to Andermatl these creatures were to be seen coming up *against the wind*, which was now blowing from the west. There was no mistake about it; countless numbers were steadily passing up the valley, but whither they were going it was hopeless to ascertain; they did not seem to turn up the St. Gotthard Road, for I remarked them the whole way up the valley to the foot of the Furka Pass Westwards."

A Carnivorous Tipulid.—Professor L. C. Miall describes[8] the early stages of a crane-fly of the genus Dicranota with aberrant habits for Tipulidæ, the larvæ of which are mostly vegetable-feeders. This larva lives in the bottom of brooks or other water streams and feeds upon the red worms of the genus Tubifex. The head of the larva is small, the alimentary canal straight and the body is provided with spiracles and tracheal gills, so that the animal can breathe in or out of water. Pupation take place in moist soil.

Notes.—Mr. Albert P. Morse begins in the current issue of *Psyche* an important paper on the Wing-lengths of New England Acridiidæ,

[6] Mag. Nat. Hist. n. s., v. III.

[7] A Year with the Birds, 202.

[8] Trans. Ent. Soc., London, 1893, 235.

and in the same issue Mr. S. H. Scudder publishes some interesting biological notes on American Gryllidæ. With this issue, *Psyche* begins its seventh volume.

Mr. G. C. Davis has prepared an interesting and valuable illustrated paper on insects injurious to celery. It is issued as Bulletin 102 of the Michigan Experiment Station.

Professor Herbert Osborn, Ames, Iowa, has bound together two of his recent papers on injurious Iowa insects which contain much valuable information. He offers a limited number of copies for sale at 30 cents each.

An excellent biographical notice of Dr. H. A. Hagen appears in *Entomological News* for December.

Professor M. H. Beckwith reports[9] that in Delaware during the past season crops of all kinds have been unusually exempt from the attacks of insects. In his summary of the year's work he discusses a number of injurious insects and experiments with remedies. The arsenites were found effective for the plum curculio, and the pyrethro-kerosene emulsion proved an excellent destroyer of aphides.

The last issue of *Insect Life* contains a full report of the Madison meeting of the Association of Economic Entomologists.

[9]Fourth Rept. Del. Ag. Expt. Station, 89–103.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

American Society of Naturalists.—The 12th Annual Meeting was held in the buildings of Yale University, New Haven, Ct., Dec. 27 and 28, 1893, Professor Chittenden of Yale occupying the chair. The meeting was largely one of business, and the following matters were discussed: A movement was inaugurated whereby a closer union could be effected between the Society of Naturalists and the affiliated societies of Morphologists, of Physiologists and Anatomists. Later the societies of Morphologists and Physiologists accepted the new scheme, which therefore goes into effect, so far as they are concerned, during the present year. It is hoped that later the societies of Psychologists and of Geologists will co-operate in the same way. By the new scheme all meetings will be held at the same time and place and a single notification and a single assessment will answer for all, while membership in one of the affiliated societies will carry with it membership in the Society of Naturalists. Another matter was the appointment of a committee consisting of Professors C. S. Minot of Harvard, S. I. Smith of Yale, H. F. Osborn of Columbia, Wm. Libby, Jr. of Princeton and William H. Howell of Johns Hopkins to appeal to Congress for action which should do away with that tax upon knowledge which is embodied in the customs duties upon instruments of research. It was pointed out that these duties were not needed for the protection of the American manufacturer, for at least in one instance, American firms were ready to afford their goods at a price a little below the foreign manufacturers to those institutions which could obtain duty free prices, while for all others they added the extortionate 65 per cent. of the present tariff. The principal subject for discussion was the present status of our knowledge of the cell, the opening papers being by Prof. R. H. Chittenden of Yale, upon the subject from the physico-chemical standpoint, and by Prof. E. L. Mark from the zoological standpoint. Two illustrated evening lectures were given, one by Prof. L. A. Lee of Bowdoin upon a Comparative Study of Labrador and Patagonia, the other by Prof. Wm. Libby, Jr. upon the Physical Geography of the Hawaian Islands. At the Annual Dinner some 75 partook. The following officers were elected for the ensuing year: Pres., Prof. C. S. Minot of Boston; Vice Presidents, Prof. S. I. Smith of New Haven, Mr. Wm. H. Dall of Washington, Prof. Wm. Libby, Jr. of Princeton; Secretary, Prof. W. A. Setchell of New

Haven; Treas., E. G. Gardiner of Boston; Committee at large, Prof. H. F. Osborn of Columbia, Dr. C. W. Stiles of Washington.

SOCIETY OF MORPHOLOGISTS.—The annual meeting of this society was held at New Haven Dec. 28 and 29, 1893. In the absence of Prof. C. O. Whitman, Prof, E. B. Wilson occupied the chair. The following officers were elected for the ensuing year: Pres., Prof. C. O. Whitman of Chicago; Vice Pres., Prof. W. B. Scott of Princeton; Secretary-Treasurer, Dr. G. H. Parker of Cambridge; Executive Committee, Dr. E. A. Andrews of Baltimore and Prof. F. H. Herrick of Cleveland. Professors E. L. Mark of Cambridge and T. H. Morgan of Bryn Mawr were appointed as a committee to co-operate with a similar committee for the Society of Naturalists in the endeavor to secure the placing of scientific instruments upon the free list. The following papers were read: Bashford Dean, the significance of Kuppfer's vesicle. H. H. Wilder, on the Phylogenesis of the larynx. C. W. Stiles, the anatomy of Fasciola magna, and a comparison with other forms (F. hepatica, F. gigantea, and F. jacksoni). F. H. Herrick, the structure and functions of certain organs occurring in the appendages of the Lobster. Arthur Willey, on some points in the development of Molgula manhattensis. C. B. Davenport, on Regeneration of Hydroids. J. P. McMurrich, some points in the development of the Isopod Crustacea. C. S. Minot, apparatus for trimming paraffin blocks C. S. Minot, a comparison of larval and fœtal types of development C. S. Minot, on Gonotomes. C. A. Kofoid, some laws of cleavage as exemplified by Limax and other Invertebrates. H. E. Crampton, reversed cleavage in a sinistral gasteropod. W. A. Locy, the derivation of the Pineal Eye from accessory optic vesicles. Charles Hill, Epiphysis of Teleosts and Amia. G. H. Parker, the structure of the Rhabdome in Astacus. G. H. Parker, the optic ganglion in the Crustacea. W. B. Scott, on some Miocene Mammals, O. S. Strong, a new modification of the Golgi-Cajal method. Miss H. B. Merrill, preliminary note on the eye of the leech. Miss S. F. Langdon, the sense organs of Lumbricus. Dr. E. B. Wilson, a demonstrative object for the study of Karyokinesis.

The following demonstrations were given: C. W. Stiles, exhibition of specimens of Distoma westermanni, Stilesia globipunctata, Stilesia centripunctata, Dracunculus medinensis, Spurious parasites. J. P. McMurrich, Ganglion cells and larva of an ectoparasitic Trematode. O. S. Strong, nerves stained by the Golgi methods. Chas. Hill, Epiphysis of Salmo. F. E. Langdon, Sense organs of Lumbricus.

THE SIXTH ANNUAL MEETING of the American Physiological Society was held at New Haven, Conn., December 28th and 29th, 1893. The following papers were read: G. D. Goodyle, Concerning the Corrosive Action of Root Hairs. J. W. Warren, on the Zymogen of the Saliva. Wm. A. Setchell, Proteolytic Ferment of Drosera. C. F. Hodge, daily life of a Protozoan, Vorticella gracilis. C. S. Minot, on Growth. W. T. Porter, on Growth of Children. H. G. Beyer, Normal Growth and Physical development of the Human Body. J. H. Pillsbury, Color Sense. C. F. Hodge, a Comparative Study of the Fovea Centralis. E. W. Scripture, some Work on Statistics. Isaac Ott, the Location of the Cerebral Motor Center of the Bladder. F. S. Lee, the Sense of Equilibrium in Fishes. J. W. Warren, a Finger Jerk. H. P. Bowditch, on Muscular Rigor. H. P. Bowditch, on the Effect of varying Rates of Interruption in Nerve. W. H. Howell, the relations of Calcium Salts to the irritability of the Muscle and Nerve. G. Lusk, the Influence of ingested Sugars in Phlorizin Diabetes. P. A. Levene, Preliminary Communication; the Blood in Phloridzin Diabetes. H. E. Smith, Acidity of the Urine. W. Gilman Thompson, Notes on the Physiological Effect of Ozonizing Agents.

The following demonstrations were given: S. J. Meltzer, Demonstration of a Pleura canula. W. G. Thompson, Demonstration of inexpensive Models for teaching purposes. A. P. Brubaker, Demonstration and Determination of the Radius of the Corneal Curvature with the Opthalmometer. W. P. Lombard, Model, showing Effect of Rotation of Ribs.

THE GEOLOGICAL SOCIETY OF AMERICA met in Boston, Dec. 27th and 29th, 1893. The following is a list of papers read before it:

Sir J. William Dawson, some recent discussions in geology (Presidential address). George M. Dawson, Geological notes on some of the coasts and islands of Behring Sea and its vicinity. Frank H. Knowlton, Fossil flora of Alaska. Sir J. William Dawson, New discoveries of Carboniferous Batrachians. William H. Dall and Joseph Stanley-Brown, Cenozoic geology along the Apalachicola river. Alfred C. Lane, Geological activity of the earth's originally absorbed gases. William B. Clark, Certain climatic features of Maryland. H. S. Williams, Dual nomenclature in geologic classification. George Huntington Williams, Johann David Schoepff, and his contributions to North American Geology. Bailey Willis, Relations of synclines of deposition to ancient shorelines. Alexander Agassiz, an

account of an expedition to the Bahamas. William B. Scott, Lacustrine Tertiary formation of the west. C. Willard Hayes, Geology of the Coosa valley in Georgia and Alabama. William H. Hobbs, Geological structure of the Housatonic valley lying east of Mt. Washington; read by J. E. Wolff. J. E. Wolff, the Hibernia fold, New Jersey. N. S. Shaler, Tertiary dislocation of the Atlantic coast of the United States. N. S. Shaler, relations of mountains to continents. N. S. Shaler, Phenomena of beach and dune sands. W. M. Davis and L. S. Griswold, Eastern boundary of the Connecticut Triassic. W. M. Davis, Geographical work for state geological surveys. W. M. Davis, Facetted pebbles on Cape Cod. Charles D. Walcott, Paleozoic intra-formational conglomerates. M. R. Campbell, Paleozoic overlaps in Montgomery and Pulaski counties, Virginia. Alpheus Hyatt, the Trias and Jura of the Western States. J. S. Diller, the Shasta-Chico series of the Pacific coast. T. W. Stanton, the Cretaceous faunas of the Shasta-Chico series. Robert T. Hill, Geology of Indian Territory and Texas adjacent to Red river. S. F. Emmons and G. P. Merrill, Notes on the geology of Lower California. William B. Clark, Origin and classification of the greensands of New Jersey. Charles R. Keyes, Crustal adjustment in the upper Mississippi basin. William H. Niles, a geological study of Lake Mohonk and Lake Minnewaska, N. Y. N. H. Darton, Geologic relations in the belt from Green Pond, New Jersey, to Skunnemonk Mountain, New York. Robert H. Richards, a prismatic stadia telescope. George Huntington Williams, Ancient volcanic rocks along the eastern border of North America. C. H. Hitchcock, Ancient eruptive rocks in the White Mountains. G. K. Gilbert, the chemical equivalence of crystalline and sedimentary rocks. William H. Hobbs, Volcanite, an anorthoclase augite rock chemically like the dacites read by G. H. Williams. H. P. H. Brumell, Further notes on the occurrence of labertite in New Brunswick, Canada. Homer T. Fuller, Alterations of silicates in gneiss at Worcester, Mass. Robert Bell, Pre-paleozoic decay of crystalline rocks north of Lake Huron. James F. Kemp, Gabbros on the western shore of Lake Champlain. Robert W. Ells, Notes on the occurrence of mica in the Laurentian of the Ottawa district. Whitman Cross, Intrusive sandstone dikes in granite. James P. Smith, Age of the auriferous slates in the Sierra Nevada. William O. Crosby, Origin of the coarsely crystalline vein granites or pegmatites. William O. Crosby, a classification of economic geological deposits, based upon origin and original structure. R. S. Tarr, Lake Cayuga a rock basin. James E. Todd, Plistocene problems in

Missouri. G. Frederick Wright, Remarks upon a supposed glaciated stone axe from Indiana. T. C. Chamberlin, Pseudo-cols. T. C. Chamberlin and Frank Leverett, Certain features of the past drainage systems of the upper Ohio basin. G. Frederick Wright, Glacial history of western Pennsylvania. F. B. Taylor, the ancient strait at Nipissing. Edward H. Williams, Extramoraine drift between the Delaware and the Schuylkill. Professor Dr. Alfred Teutzsch, Königsberg, Prussia, Interglacial series of Germany. Warren Upham, the Madison type of drumlins. Warren Upham, Diversity of the glacial drift along its boundary. E. O. Hovey, Notes on the microscopic structure of siliceous oölite.

Indiana Academy of Science.—The Ninth Annual Meeting was held at Indianapolis, December 28 and 28, 1893, when the following papers relating to Natural History were read and discussed:

An Alphabetical and Synonymical Catalogue of the Acrididæ of the United States, W. S. Blatchley. On the Hibernation of Turtles, A. W. Butler. Some Notes on a Variety of *Solanum dulcama*, R. Wes. McBride, Work of the Botanical Division of the Natural History Survey of Minnesota, D. T. MacDougal. Indiana Fishes, C. H. Eigenmann. The Fishes of Wabash County, A. B. Ulrey. Review of Botanical Work in Indiana with Bibliography, L. M. Underwood. Notes on an Imbedding Material, John S. Wright. Recent Notes on Indiana Birds, A. W. Butler. The Distribution of Indiana Birds, A. W. Butler. On the Occurence of the Rarest of the Warblers (*Dendroica kirtlandii*) in Indiana, A. B. Ulrey. Histology of the Pontederiaceæ, E. W. Olive. Growth in Length and Thickness of the Petiole of Richardia, Katherine E. Golden. The Geographical and Hypsometrical Distribution of North American Viviparidæ, R. Ellsworth Call. The Effect of Light on the Germinating Spores of Marine Algæ, Melvin A. Brannon. Notes on Saprolegnia, George L. Roberts. Contributions to the Life-History of Notothylas, D. M. Mottier. Some South American Characinidæ, with Six New Species, A. B. Ulrey. Should the Study of Natural Science in the Lower Classes of the Public Schools be Encouraged, W. W. Norman. The Detection of Strychnine in an Exhumed Human Body, W. A. Noyes. Absorption of Poisons by Animal Tissue After Death, P. S. Baker. Induration of Certain Tertiary Rocks in North-Eastern Arkansas, R. Ellsworth Call. The White Clays of Southern Indiana, A. W. Butler. The Effect of Environment on the Mass of Local Species, C. H. Eigenmann. The Ash of Trees, Mason B. Thomas. Poisonous Influence

of *Cypripedium spectabile*, D. T. MacDougal. Notes on the Biological Survey, Mason B. Thomas. Notes on Sectioning Woody Tissues, John S. Wright. The Stomates of Cycas, Mason B. Thomas. Symbiosis in *Isopyrum biternatum*, D. T. MacDougal. Our Present Knowledge of the Distribution of Pteridophytes of Indiana, Lucien M. Underwood. Concerning the Effect of Glycerine on Plants, John S. Wright. The Adventitious Plants of Fayette County, Robert Hessler. Bibliography of Indiana Ornithology, A. W. Butler. Bibliography of the Batrachians and Reptiles of Indiana, O. P. Hay. Bibliography of Indiana Mammals, A. W. Butler and B. W. Everman

The President's address by Dr. J. C. Arthur discussed "The special senses of plants."

NATURAL SCIENCE ASSOCIATION OF STATEN ISLAND, Nov. 11th, 1893. Mr. William T. Davis exhibited specimens of *Anodonta fluviatilis* Lea, and read the following memorandum:

Rediscovery of Anodonta fluviatilis on Staten Island.—During the past summer *Anodonta fluviatilis* was found in the Bull's Head pond. Only empty shells were discovered, chiefly such as had been opened and their contents eaten by musk rats. Mr. Sanderson Smith has informed me that, as far as he remembers, the specimens admitted into the list of fresh and salt water shells of the Island, originally published in the Annals of the New York Lyceum of Natural History, in May, 1865, and subsequently republished with a few changes, in our Proceedings, as Extra No. 5, March, 1887, came from the ponds near Clifton. None have been reported in many years, so the present specimens from Bull's Head are worthy of being placed on record.

Mr. Arthur Hollick exhibited specimens of drift bowlders, containing fossils, from Prince's Bay, and read the following memorandum:

A Recent find of Drift fossils at Prince's Bay.—On the 29th of last month, while examining the Drift rocks at the base of the Prince's Bay bluff, I found four bowlders containing fossils, representing four different geological horizons, viz.: Hudson shale, with *Orthis*, probably *O. testudinaria* Dal; Helderberg limestone, with *Strophodonta beckii* Hall, *S. varistriata* Conr. *Strophomena rhomboidalis* Wahl. and *Orthis oblata* Hall; Oriskany sandstone, *Spirifera arrecta* Hall; Schoharie grit, with *Atrypa reticularis* L. and fine specimens of some Bryozoon not determined. By far the larger part of the bowlders was left behind and will receive further attention on some future occasion. These do not add any new species to our already published lists of Drift

fossils, except in the case of the provisionally determined *Strophodonta varistriata*, but the discovery, in one day, in a very limited area, of four fossiliferous bowlders, representing as many different geological horizons, is perhaps worthy of note.

THE BIOLOGICAL SOCIETY OF WASHINGTON, Jan. 13, 1894.—Communications: Dr. Theo. Gill, the Segregation of the Osteophysarial Fishes as Fresh water Forms. Mr. Robt. T. Hill, a new Fauna from the Cretaceous Formations of Texas. Dr. C. W. Stiles, the Teaching of Biology in Colleges. Mr. J. N. Rose, a Botanical trip to Northwestern Wyoming.

SCIENTIFIC NEWS.

The death is announced at Paris of the biologist Dr. Chabry, known for his work in experimental teratology.

M. Paul Fischer, the conchologist of the Museum d'Histoire Naturelle, died Nov. 29, 1893. He contributed largely to the literature of science, his Histoire des Mollsques du Mexique being, perhaps, the best known of his works.

Dionys Stur, late director of the K. K. geologische Reischsanstalt of Austria, died at Vienna, Oct. 9th, 1893.

The loss to zoology by the recent death of Prof. Milnes Marshall, of Owens College, Manchester, England, is not easily estimated. There is a striking similarity in the manner of his death and that of his instructor, the lamented. Marshall was climbing one of the peaks ef Scfeawll, in Cumberland, when his foot slipped, and he fell over a precipice. His death occurred June 31, 1893.

A prize of 1,800 francs is offered by the Italian Geological Society for the best memoir on the present knowledge of the paleozoic and mesozoic formations in Italy. This paper will follow one by D'Archiac entitled "History of the Progress of Geology", and must be presented before the end of March, 1896.

Dr. Harrison Allen has been appointed director of the Wistar Institute of Anatomy of the University of Pennsylvania.

The Owen's Memorial Committee has entrusted the statue of the late Sir Richard Owen to Mr. T. Brock, R. A.

The late Professor Newberry's name is to live in a fund which the scientific societies of New York have resolved to raise, It will be called the John Strong Newberry fund, be not less than $25,000, and the income derived from it will be devoted to the encouragement of scientific work in geology, paleontology, botany and zoology. Professor N. L. Britton is secretary to the subscription committee.

Professor Ben. K. Emerson, of Amherst College, and of the U. S. Geol. Surv., who met with a serious railway accident last summer, and was reported killed, has so far recovered that he has started on a trip around the world for rest and recuperation. He visits Italy, Egypt, India, Java and Japan. Prof. Emerson has been engaged for a long time in mapping the crystalline rocks of Central Massachusetts and Connecticut.

A member of the Anthropological Society of Washington has placed in the hands of the Treasurer of the Society a sum of money to be awarded in prizes for the clearest statements of the elements that go to make up the most useful citizen of the United States, regardless of occupation. The donation has been accepted, and the Society has provided for the award of the following prizes during the present year (1893) under the following conditions:

Two prizes will be awarded for the best essays on the subject specified above, viz: A first prize of $150 for the best essay, and a second prize of $75 for the second best essay among those found worthy by the commissioners of award.

These prizes are open to competitors in all countries.

Essays offered in competition for the prizes shall not exceed 3,000 words in length, and all essays offered shall be the property of the Anthropological Society of Washington, the design being to publish them at the discretion of the Board of Managers, in the official organ of the Society, the *American Anthropologist*, giving due credit to the several authors.

Each essay should bear a pseudonym or number, and should be accompanied by a sealed envelope bearing the same pseudonym or number, and containing the name and address of the competitor; and the identity of the competitors shall not in any way be made known to the Commissioners of Award.

Essays must be type-written or printed, and must be submitted not later than November 1, 1893. [Since changed to March 1, 1894].